THE WORLD IS ITS FIELD.

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INTERNATIONAL ASPECTS OF THE ISTHMIAN CANAL.

The construction of the best Isthmian canal is of so grave importance to Britain, France, and Germany, as well as the United States, that we ask most earnest attention to General Abbot's significant paper and the prefixed editorial introduction.

General Abbot, after retirement from the Corps of Engineers, U. S. A., spent three years as a member of the International Commission in minute study of the Isthmian canal question, bringing to it the pre-eminent ability which had already ranked him as one of the leading hydraulic engineers of the world. His work on the Mississippi is a classic.—THE EDITORS.

An Editorial Introduction to an Article by Gen. H. L. Abbot.

THE spectacle of a great nation committing a great folly may well cause the gravest distress. When, furthermore, that great nation, having received the confidence, the hearty accordance of a free hand in a free field, and the cordial Godspeed of the greatest of civilised powers, to the end that it may act for the best interests of material progress the world over, yet purposes to prostitute its opportunities at the spur of a narrow impatience—when, in short, the United States, absolved of treaty limitations, given sole powers and charged with sole responsibilities in the matter of the Isthmian Canal, appears ready to commit itself to so dubious, possibly impracticable, and certainly inefficient a project as the Nicaragua scheme—then it is time, not for despair, but for every effort to awaken reason and strengthen judgment before the fatal choice is made irrevocable.

The extraordinary thing is that this incredible folly is proposed in the face of facts which it has taken years of time and millions of money to obtain. According to the report of the "Walker Commission" the Nicaragua Canal would be 135 miles longer than the Panama, would have a greater summit elevation, more locks, and more and more difficult curvature; it would require 33 hours' time of transit for deep-draught vessels against 12 hours by the Panama route: it

has no natural harbours at either end, while the Panama line has an excellent roadstead at the Pacific side and a serviceable harbour already in use on the Atlantic; the knowledge of the country and hence of possible contingencies in building is much less complete; the diffuseness of the work would make the difficulty of securing sufficient labour greater; there is no construction plant on the ground, and no means of transportation paralleling the line, while very perfect equipment in both regards exists at Panama; the cost of construction would be $45,000,000 more than the cost of completing the Panama undertaking, and the completed canal would cost $1,350,000 per annum more to maintain.

And yet, because of the terms offered by the Panama Canal Company, the commission is of the opinion that the most practicable and feasible location is that known as the Nicaragua route. In other words, they consider the price said to have been named by the French interests—about $100,000,000—unreasonable. It is fair to state, however, that the Panama representative denies that any figure was fixed.

Taking the figures as given, the net cost of the Panama Canal, finished, would be approximately $60,000,000 more than the estimate for the Nicaragua route. But the Nicaraguan estimate has been increased by each new commission. Even this last, in the light of all experience, will be enormously exceeded in construction. The Panama figures are based on actual knowledge gained in building nearly half the work, uncertainties being practically eliminated. And this is not the whole case. The saving of $1,350,000 a year in maintenance and operation would equal, on a 3 per cent. basis, a capitalisation of $45,000,000. This alone would nearly wipe out the alleged excess of construction cost. Further, Mr. George S. Morison, in a memorandum of dissent, urges that in certain particulars a wholly unnecessary expense of construction was charged against Panama, amounting to $10,000,000. Further, (and very reasonably,) that the estimation of engineering expense at the same percentage in both cases is manifestly unfair to the thoroughly explored Panama line, and that on this account $12,000,000 more should be added to the Nicaragua estimate. If this be so, the total would favour Panama by some $7,000,000, even paying the alleged price of the concession.

THE ENGINEERING MAGAZINE has no particle of concern with the rival interests except that of urging the measure which will in the end best serve the work of the world. It stands, as it has consistently stood from the outset, an outspoken advocate of the Panama Canal because the facts prove it will be the most serviceable to commerce, the most economical in operation, the greatest in potential traffic capacity, and the most adaptable to the rapidly increasing demands of navigation. In

other words, it is the best tool for the intended use. The same policy which leads the Magazine steadily to urge the scrapping of inefficient machinery—on the principle that economy and capacity in operation outweigh immeasurably expense of installation—leads it also to stand squarely for the completion of the Panama route and the utter rejection of the Nicaraguan. For the United States, the very embodiment of restless activity in seeking the best appliances—of daring in casting out everything which is below the maximum of serviceability—to choose now deliberately the poorer instrument in this colossal investment, would be a reserval of national policy from which would grow a harvest of mortification and loss for years to come.

Concerning the propriety of the price said to have been asked by the French company we have no opinion, nor any concern with mere financial negotiations. It may be their business has been very badly handled. But the business of the United States will be much worse handled if they allow a mistaken enthusiasm, a false sentiment, a blind or prejudiced partisanship, or bad judgment to plunge them headlong into the morasses of the Nicaraguan project. Obviously it is to the interest of the New Panama Company to sell, and of the United States to buy. There must be a better way out of the muddle than that which the commission recommends.

We waited the report of the present commission with the admission (March, 1900,) that it was "conceivable that the merits of the Nicaraguan route would be so commanding as to make it advisable to abandon the work done on the other line and begin anew." The report, on the contrary, shows that at every conceivable point the Nicaraguan route is inferior. The United States will fall lamentably from every ideal in their history, political or industrial, of they seize the inferior and let the better go. If they are so misguided, others, wiser, will take what America rejects and, having the best, will leave her vanquished and dishonoured. Her perversity will be Britain's or Germany's opportunity.—THE EDITORS.

PRESENT CONDITION OF THE PANAMA CANAL.

By Gen. Henry L. Abbot.

THE history of the Panama Canal is maked by three distinct epochs. Inaugurated at the International Congress of 1879, with estimates based on no sufficient local investigations, and with contracts preceding the surveys of its engineers, the original "Compagnie Universelle du Canal Interocéanique," although supported at first by the reflected glories of the recent success at Suez, was compelled at the end of 1888 to abandon its undertaking from want of

funds. The epoch of liquidation followed, marked by good sense and administrative ability of a high order. The receivers called to their assistance a commission of the ablest engineers of France to advise as to the technical features and the merits of the undertaking when conducted on business principles. The conclusion was reached that, while under existing conditions the construction of a sea-level canal was out of the question, a canal with locks was entirely practicable and might be made to meet all the requirements of a vast traffic; but that before beginning work on a grand scale, detailed examinations and investigations ought to be made to determine the best possible project for such a canal. To carry out this plan, the "Compagnie Nouvelle du Canal de Panama" was finally organized in October, 1894, with a capital of sixty-five million francs, and since that date has been at work with two objects in view:—(1) To investigate every element of the problem in the most thorough manner, in order to construct the best possible canal; and (2), so to locate the excavations as to avoid useless expenditures, whatever plan might ultimately be adopted. This paper is designed to set forth briefly the results attained.

Nature had placed on the Isthmus of Panama far less obstructions to the construction of a ship canal than on any other possible route between the oceans. Here only three formidable difficulties were to be apprehended; the cut at the continental divide, regulation of the Chagres river, and the tropical climate. Each will be considered in turn.

The deep cut at the Culebra has now quite lost the ancient terrors which hung over it in the closing days of the old company. The cutting at that date was in disintegrated materials near the surface, and serious caving and sliding had occurred, partly from natural causes and partly from neglect to secure proper drainage. The old company had made numerous borings, and they have been multiplied by the new company, with deep pits permitting the material to be inspected to the full depth adopted for the bottom of the canal; six million cubic yards have actually been removed since the resumption of the work, so placed as to secure depth rather than width and thus to throw light on future conditions; and lastly a tunnel 2,100 feet long and 20 feet by 13 feet in cross section has been driven at a low level without difficulty, at the point where the worst sliding had occurred. All the evidence thus secured concurs in establishing the fact that the dangerous material has already been passed, and that future deep cutting will lie chiefly in an indurated argillaceous schist which stands well even on steep slopes and in which caving is not to be feared. It may be added that the remaining heavy excavation is exaggerated in popular estimation, and the fact is often ignored that a very large volume has al-

ready been taken out. For example, the height of the continental divide on this route is constantly stated at its original figure, which on the line of the axis of the canal was really 345 feet above tide. The bottom of the cut there has now attained a level of 148 feet; and this, rather than the historic height, should be used in comparing the Panama with the other routes. Moreover, the length of the deep cutting, including the Emperador and Culebra sections, extends over about only five miles, and the really formidable cut over less than a mile. In fine, the old phantom of a sliding mountain and an impassable continental divide has been definitely laid at rest by the operations of the new company.

The problem of the regulation of the Chagres river demanded investigations of the most elaborate character. It is a stream having a basin above Bohio of about 700 square miles in surface. From this point the canal and river follow different routes to the sea, and at Gamboa, 13 miles above, they again separate. One problem, therefore, was to provide for the joint occupancy of 13 miles of valley without allowing interference with the canal in times of river floods; another was to determine with certainty whether the river could be made to supply sufficient water for canal purposes under the demands of any probable prospective traffic.

The records of the old company and of the liquidation period had contributed much valuable data as to the hydrography of the river during those years; but the new company inaugurated a series of observations without precedent on any tropical river. They included continuous registration of water level by tide gauges, frequent measurement of the discharge at all stages, daily rain records, and a collation of all known facts bearing on previous floods. Borings were multiplied at all sites favorable for the construction of dams and locks. Accurate level lines were run for scores of miles through the tangled forests to determine with precision the contours of projected reservoir lakes. In a word, nothing was omitted to permit the application of engineering science to every possible solution of the two hydraulic problems. Observations of this character have been in progress during the seven years since the new company undertook the work. Even today it continues to determine accurately the volume carried by the river at bi-hourly intervals at the three governing stations, and thus amply verifies the conclusions, which may be briefly stated as follows:

The Chagres river is characterized by two distinct regimens, one corresponding to the season of heavy rains, from May to December both included, and the other to the dry season covering three of the four remaining months of the year. During the former, the average

discharge is about 3,900 cubic feet per second at Gamboa and 5,400 at Bohio, but it is subject to frequent freshets in which the volume may rise to 25,000 or even to 30,000 cubic feet, lasting however only for an hour or two. During the past quarter of a century, and so far as can be determined by the records of the Panama Railroad during the past half of a century, only five great floods have occurred. In by far the largest of them, that of November, 1879, the river carried a maximum volume liberally estimated at 112,000 cubic feet per second at Bohio, and at 73,000 cubic feet at Gamboa, but only during a period two or three hours. The plans of the company for regulating the floods are based on the figures of this year, which are known to be far in excess of any other. During the dry season the Chagres is a quiet, peaceable stream with at Gamboa an average discharge of about 1,100 cubic feet per second, and in years of greatest drought a minimum average of 550 cubic feet. At Bohio the latter is about 750 cubic feet. The company has been careful to make its flood estimates err, if at all, in excess, and its low-water estimates err, if at all, by under-valuation. The provisions for river regulation contemplate two great artificial lakes—one formed by a dam at Bohio, creating a lake having 20 square miles of surface, and which for 13 miles will form the bed of the canal; the other above, on the upper river, for storage of water for lockages, etc. Together they will allow any excessive flood water to be held back, to be discharged gradually and thus rendered harmless to navigation. Such a system is superior to one immense natural lake, because, on the American Isthmus, the rainfall varies not only from year to year but also by periods covering several years. These variations cause corresponding variations of lake level, which are extremely difficult to regulate where the surface is large. Only one criticism has been raised against the reservoir plans adopted by the company. It has been asserted by those ignorant of its investigations that there will possibly be danger of leakage in the artificial lakes to be created. This matter was not overlooked by the engineers. Not only were the geological reports favorable, but the matter was put beyond question by a careful study of the monthly ratio between downfall and drainage in the basin above Bohio. Four years of records, all in perfect accord, have demonstrated that during the eight months of rains the soil becomes saturated with water, which in the dry season filters out into the river and constitutes a great part of the discharge at this season. As its source is much above the level established for the lakes, no leakage can escape from them because the soil is already super-charged. To explain in detail the calculations on which these several conclusions rest would far exceed the limits of this article, but they leave no doubt

as to the correctness of the conclusions. The floods can be easily and perfectly controlled. So far as the low-water volume is concerned, an annual traffic of twenty-three million tons (more than double that of the Suez canal) can be certainly accommodated, with an ample water supply for lockages, electric lighting, and operating power. In a word, the investigations of the new company have proved that so far from being an obstacle to the canal, the Chagres river, regulated on the familiar system of locks and dams, is admirably suited to meet all the needs of navigation. No better source of supply could be desired.

It remains to consider the climate. Throughout the entire region where an Isthmian canal could be constructed, the temperature is that of the tropics, varying but little during the year from the annual mean of 79 degrees F. This uniformity causes for the white race muscular exhaustion forbidding hard manual labor, but from which the blacks of the West Indies do not suffer. The former can direct the works but the latter must execute them. Experience both on the Panama Railroad and on the Canal has shown that when the virgin soil is first disturbed much sickness is caused by the malaria thus generated, but when excavation has gone below this level to the deeper subsoil far less occurs. The hospital records of the company during the past twenty years demonstrate this fact, and the progress already made in the excavations (about two-fifths of the entire volume required) makes it evident that there is no reason for apprehending serious trouble from sickness. In this connection the matter of rainfall cannot be ignored. At Colon, on the Gulf coast, the annual precipitation is about 129 inches, in the interior about 94 inches, and on the Pacific coast about 57 inches—all well determined by observations covering many years. There is every where a clearly defined dry season of about four months available annually for specially difficult operations. Moreover, the heaviest work lies in the interior where the precipitation is comparable with, although considerably larger than that on the Gulf coast of the United States. In Nicaragua the conditions are far less favorable. The annual rainfall near the Gulf coast, where the heaviest excavations are required, appears to be about 250 inches, and there is no dry season. In the interior and on the Pacific coast much less rain falls, and there is a dry season; but even here the volume seems to exceed somewhat that in the corresponding portions of the Panama district. The matter of rainfall is of vital importance not only during the construction of the canal but also in its subsequent operation. The danger of earthquakes, very formidable for the locks of a modern ship canal, is also much greater in Nicaragua than in Panama.

The foregoing facts make apparent how different is the present condition of the Panama Canal from what it was at the formation of the new company in 1894. Its work has been continuous and rich in results. The plans are perfected, based on a thorough understanding of the subject. The route now presents no serious difficulty from an engineering point of view. The concessions are ample, and good progress has been made in actual construction. A parallel railroad, the existence of numerous quarters for laborers, and a considerable supply of tools, are available for immediate resumption of work on a grand scale. As compared with its most formidable rival, nature has given a route only about a quarter as long and requiring only about half the number of locks; an exemption from about fifty miles of river navigation which cannot but be dangerous to great ocean steamers by reason of very bad curvature and troublesome fogs and winds; and, lastly, harbors which have aided in making it the favorite transit route since the Spanish occupation four hundred years ago, meeting all the demands of commerce heretofore, and admitting of future improvements at moderate expense, should such become desirable. It seems clear that if the two canals were opened to navigation there could be no commercial competition between them, taking into account the delays and the costs of transit, including tolls, tugs for steering, etc., and insurance rates.

In fine, the present condition of the Panama Canal may be summed up as follows: The operations of the new company have demonstrated that the route possesses so great natural advantages that when completed it will control the transit of the Isthmus. The estimates of the International Commission of Engineers, representing not only France, but also England, Germany, Russia, the United States, and Colombia, have placed the costs of completion of a canal suited to all the probable needs of navigation for fifty years, and admitting of enlargement if ever desirable, at one hundred million dollars—only half of the costs of construction of the Nicaragua Canal as estimated by the Isthmian Canal Commission. The new company has everything in readiness to begin work on a grand scale, except the funds. If the United States do not care to own the route, is it to be supposed, in view of the approaching commercial struggle between the great maritime powers, that one hundred million dollars will not be forthcoming to win the prize? One of the most remunerative investments ever made by the British Government was its purchase of a controlling interest in the Suez Canal. It was a business transaction which secured the desired control without the Government appearing in the matter, except to receive interest, and which involved no outlay to be liquidated by taxation.

THE HOME ENVIRONMENT OF BRITISH WORKINGMEN.

By Percy Longmuir.

Mr. Longmuir's thoughtful study of industrial environment, though confined to British conditions, has quite too-general appropriateness everywhere. The time has come for engineering manufacturers—wherever they may be located—to arouse themselves to a perfectly clear appreciation of the fact that it is no longer practicable or profitable to ignore the physical and mental conditions under which employees, and the children of employees, must spend their lives. The era of world competition is here. In home markets, as well as in foreign markets, the fittest only can survive and prosper. And in view of the practical importance of the problem which Mr. Longmuir so lucidly discusses, we commend special attention to the editorial comment appearing elsewhere.—THE EDITORS.

GENERAL conditions in Britain, Germany, and the United States are today receiving much attention and are being discussed from many points of view. The thought bestowed on these conditions generally results in an adverse criticism of British methods and a strong and unqualified condemnation of British trade unionism. Whilst it contains much of truth, this criticism seems unduly severe. The dominating policy of trades unionism has undoubtedly restricted the expansion of British trade; but, in all honesty, can the extremely rapid development of the United States, for instance, be traced solely to the absence of this hindrance? May there not be in addition to the restrictive union policy, other causes at work in Britain which limit progress and effectually bar advance? Is there not room for improvement in British commercial methods and in the education of employer, workman, and merchant? Are the energy and capital at present being expended on

technical—and latterly, to a more limited extent, on commercial —education a necessary assurance that the right methods are being adopted? Is the present public spirit of Britain one likely to meet successfully a foreign invasion of what have hitherto been regarded as the sole preserves of British commerce or industry? Is it such as can successfully compete with foreign rivals in its own home market? Are the present conditions of British works, their management, and their workmen, such as will result in an ever-increasing standard of efficiency, combined with a low or decreasing cost of production, in an article which must meet competition in home and foreign markets alike?

Surely a long list of questions, and too many to be answered within the compass of one article; but as a solution of any one of them will contribute much to the future welfare of British industry, I propose to examine the environment—social, workshop, and educational—of perhaps the most vital element—the workmen. By such examination we may arrive at some possible means of improvement.

First, I shall endeavour to depict briefly the social environment of that lower stratum of artizans and mechanics which forms the greater part of the population in our large industrial centres. Bred and born for the most part in what thirty years hence, it is hoped, will be regarded as congested slums, the child grows or, more correctly speaking, is allowed to grow, in the same rut as its parents and grandparents. The street is its nursery, a crowded kitchen its dining room, and for sleeping accommodation it has a share of a bed in a room crowded to excess. Is it a wonder that, reared in an atmosphere of this kind, the coming artizan lacks originality, and that stamina and vital force alike are low? As evidence of the importance of physical development under present conditions, we may for a moment examine the candidates for enlistment in the regular army, quoting from Col. F. N. Maude's paper on "National Military Reform" in the *Contemporary Review*, February, 1901:—"One half of the recruits for the regular forces are rejected at the medical inspection and very many more would-be young soldiers never reach the doctor's hands at all. Making every possible allowance, it seems safe to assume that our 40,000 accepted recruits represent 100,000 applicants."

These figures give in striking emphasis a sad tale of lack of physical development, and if this is the case with the national army, what of the candidates for our vastly more important industrial army? How many of them could pass a reasonable physical standard? Surely no stronger argument can be advanced for the better environment of

the industrial classes than this decay of national physique. The matter thus resolves itself into an economic necessity for the training of better specimens of humanity. Undoubtedly upon the strength and stamina of its industrial army depends to a great extent the final position assumed by the nation in the present competitive struggle.

Conditions similar to those described earlier are not familiar to the smaller manufacturing areas, but in the larger ones, and also in the larger coal-mining and iron-working communities existing as semi-towns in various parts of the country, these conditions are very real. An examination of four typical cities—say Glasgow, Manchester, Birmingham, and Sheffield—will bear out this assertion.

The education the children receive, good in its way and given in fairly well equipped schools, by efficiently trained teachers, is seriously discounted by the home surroundings, and especially by parental interference. The future working man of Britain in the majority of cases is handicapped from the day of his birth, left—if a younger child—to the care of elder brothers or sisters, allowed to get his moral training in the streets, and put to work as an errand boy or shop lad just at the time his school training is beginning to be effective. At fourteen or fifteen he is placed in works and put to a trade for which in nine cases out of ten he has no aptitude or inclination. At eighteen or twenty, little remains of his early and somewhat limited education. He marries early, rears a family in which his own training is repeated, and generally follows in the steps of his forebears. If he has any guide at all, tradition is the only one followed. Therefore, as it is traditional to regard the capitalist from an antagonistic point of view, he follows his guide most blindly in this respect, and improvements effecting increased or more economical production he regards as an indication of future lack of employment to himself or his children and therefore does his best to minimise what to him may seem a personal injury. His interests and amusements are few and do not tend to widen his scope of observation. At the theatre, maudlin sentimental plays giving a false estimate of life are his favourites; the one afternoon he has free he gives to football, and that unfortunately as a spectator and not a player; horse racing and various forms of betting complete the list. It therefore happens that the page of a daily paper most familiar to him is the sporting one, and if of a slightly developed type he may follow the police court news; but in very few cases is an attempt made to follow the policy or real progress of his own country or others. Even at an election time he makes little effort to analyse the policy of contending parties, and his vote is recorded purely on the result of

emotional or traditional environment. Earnest thought or the just recognition of any particular policy are absent factors in his composition at such times. Briefly, this represents the average of the class under discussion; is it then a matter for wonder or surprise that among British industrial workers so little interest is manifested in the competitive struggle now taking place between three important nations, and that the general spirit is one of antagonism to an advancing standard?

An environment no less important than social surroundings is that of the workshop, and it must be confessed that in this respect British shops offer much scope for improvement. The actual conditions of the average workshop can hardly be classed as those likely to favour the development of the latent powers of each of its workers. Neither can the general "tone" or atmosphere be described as that likely to spur them onward or to make them keen intellectually or industrially. Robust physical development cannot be expected with workers spending the greater part of their lives in conditions such as are represented by the average shop. Good lighting and perfect sanitation are essential, yet the scant attention devoted to the latter subject may be readily noted by observation in any industrial centre in Britain. Important factors such as heating or ventilation receive but little attention, and in the majority of cases are ignored entirely.

The present tendency among large establishments to migrate to less crowded or suburban districts is, from our present point of view, highly commendable. Though as yet in its infancy, this plan has already proved entirely successful with several large firms in Britain. Land in abundance, new and up-to-date workshops of one storey only, heating and ventilation well planned, and ample conveniences for workers' comfort—such conditions are, in contrast with those presently existing, almost Utopian. It is, however, hardly necessary to urge the importance of shop environment in the pages of THE ENGINEERING MAGAZINE. The matter was fully and attractively illustrated in Mr. Patterson's article in the January issue, 1901. One further point, however, may be mentioned—that of evening study. With the adoption of sanitary conditions and conveniences that lend themselves to the worker by assisting him to perform in comfort an arduous day's work, evening study not only becomes a possibility but a pleasure. The present class of fatigued and more or less enervated evening students would, under such conditions, be replaced by a fresh and vigorous set of youths who would stimulate each other to head their respective technological ladders.

The mention of evening study brings us to the question of the present educational environment of British working men. As stated earlier, when speaking of social conditions, the education received at a public elementary school is good, but the child is removed from it at too early an age and the influence of parents and surroundings tends to obliterate the little good done. In the comparatively few cases in which evening study is taken up, the boys start far in advance of their capacity and the object sought is in most cases the acquirement of a few science certificates rather than actual scientific training. Class attendance may be fairly easy to most lads, but home study so necessary, is, by the very atmosphere of home and more or less natural disinclination, made impossible except in the case of boys possessing marked ability. Then again the daily work of many boys unfits them for serious evening work. Rising at five o'clock in the morning, as many of them must do, and undergoing a more or less arduous day's work from six to five in the evening, their inclinations naturally trend to lighter matters than study. A boy attending an automatic machine throughout the day is in far better condition physically, not of necessity mentally, for evening study than his fellow of the millwright's gang who may have been kept going with hammer, chisel, and file all day through—or than others who may have been perspiring in forge or mill and engaged on work of a peculiarly fatiguing nature. Consequently the majority of evening students come from the lighter trades. Moulders, steel or iron melters, rollers, forgemen, and kindred spirits are comparatively unrepresented, whilst the lighter branches of engineering—pattern making, building, and similar industries contribute far larger numbers of students. It therefore results that the heavier trades receive no impetus, and this fact, in combination with the decay of apprenticeship and the poorly equipped recruits entering these industries, is making the matter serious and worthy of national consideration.

Having thus briefly reviewed three divisions of environment—social, workshop, and educational—it behooves us to examine lines of possible advance, or advances that are being made by industrial pioneers. Firstly, the attention now being devoted by municipalities in many large centres to housing problems will, it is to be hoped, fructify in much useful reform in this direction. Naturally the most tempting solution lies in the opening out of suburban districts, with the adoption of rapid and regular modes of transit between these districts and the hearts of the towns. Away from the congested areas of town life the development of children might proceed on more childlike lines and

the present stunted and preternaturally sharp growth be replaced by a vigorous, full-chested class of healthy children, who at a later age would view industrial life with normal eyes and a fair sense of proportion.

Before passing on to education, a few words on parental influence are in keeping with our subject. The view taken by the rank and file of the working classes, that children should be a source of profit at the earliest possible moment, must be combatted, and if no other method avail, be exterminated by government interference. Children who, almost the very day they are exempt from school attendance, are put" to help to earn their keep" as the parents express it,are not the best augury for the future capacity, as a whole, of the working forces. All forms of child labour, whether as "half-timers" or workers out of school hours, are too great a strain on our credit account and are economically unsound. A further matter of note is that the more squalid the parental surroundings the more numerous the progeny. Not admitting the truth of Zola's views as set forth in "Fécondité," we are nevertheless bound to admit that an improvement in quality would admit of a decrease in quantity and at the same time give the parents more opportunity to realise their responsibilities.

The age limit of children leaving elementary schools might be profitably fixed at fourteen, and attendance up to that age made compulsory irrespective of the child's attainments. If to this could be added the universal adoption of the metric system,* thereby saving two years in every child's school life, we should indeed be approaching something of excellence in our system of education. The school training should be general and most thorough; it should put the child in such a position that in later life he can reason from the data around him; in short, the whole aim should be to develop to the fullest extent the child's thinking powers. The training, whilst wide and thorough, should not attempt too much or in any way imitate certain higher grade schools which make a practice of overburdening the children with a mass of ill-digested and ill-assorted scientific and other lore, and an inkling of mathematics in addition to a foreign language

* This interesting suggestion brings up the point that it is the decimal system, rather than the metric unit, which constitutes the labour-saving feature of the French and German weights, measures, and currency. In the United States a large proportion of the advantage indicated by Mr. Longmuir is secured without any radical change of standards. The measures of weight and dimension are in general the old English ones, with elimination of a number of intermediate and unnecessary denominations; but the fractional subdivisions, in engineering work, at least, are expressed in decimals. The civil engineer speaks of feet and hundredths, the mechanical engineer of inches and thousandths. The benefits of decimal notation are secured without the upheaval involved in the adoption of the not-too-convenient metric standards.—THE EDITORS.

or so. In the first place, due importance must be given to the three R's. Put the children in the way of realising their own literature and teach them to follow intelligently the progress of their own country. History and comparative geography give exact information and at the same time put the child in a position to reason out cause and effect for himself. He can then grasp the position of his own and other nations, and such a training is of far greater utility to a working lad than a smattering of another language which he never has time to master nor opportunity to apply, with the consequence that he soon loses the little he has acquired. With regard to the sciences, it is better far to attempt few and those thoroughly; therefore chemistry, the "grammar of science," is recommended, and let the training in this branch be thorough and practical—the reverse of cramming. Free-hand and model drawing, with mathematics, complete a syllabus sufficiently full. A boy so trained, on applying for work in his fifteenth year, is in the possession of a sound elementary education—not a higher-grade prodigy by any means, but a common-sense training that will be of benefit to him in every stage of his industrial career. His tastes in literature have been directed and he has been taught how to get the best out of a book, and is therefore in a position to obtain full benefit from the technical books or papers treating of his particular industry. The estimation of cause and effect, chemical knowledge, and skill in drawing, are all rungs in the boy's ascent of his industrial ladder. Having been taught the use of his faculties, such a boy all through life would keep in touch with the moving spirit of the age. Competition to him would be but an incentive to further effort. An army composed of such units would not mar its own advance by opposing new ideas and labour-saving improvements.

Evening classes under these conditions assume less importance, for the boy, having been taught the use of his brain, is continually assimilating. The chief aim of evening classes then would be to minimise the delimitation of apprenticeship; the instruction given would savour more of a technological than a technical character, and the motive (which presently is the acquiring of certificates) would become actual training. The beneficial effect of such a training cannot be overestimated.

In advocating workship reform the capitalist naturally wishes to know if this expenditure on such matters as sanitation and ventilation will be justified by results; in short, will it pay so to better the conditions of the workshop? Undoubtedly; for in the first place this outlay on the comfort of his factories results in better and more uniform

production of work. The best type of workmen seek employment in such factories, and an employer so situated can in the busiest of seasons ever make his pick of skilled labour. Labour troubles are of comparatively rare occurrence in establishments which to some extent consider the comfort and convenience of their workers. Secondly, and of far greater moment, better men are trained to fill the ranks of the industrial army, men who recognise their responsibilities and duties—more than that, fulfil them; who, when an arduous day's work is performed in comfort, have sufficient energy left to study the difficulties of their trade and the progress of their industry. Sound training, healthy and congenial home surroundings, and active employment in sanitary workshops, will contribute much towards removing discontent and unhappiness. Such influences and surroundings would result in a community famed for its zeal and always in the forefront of the march of progress.

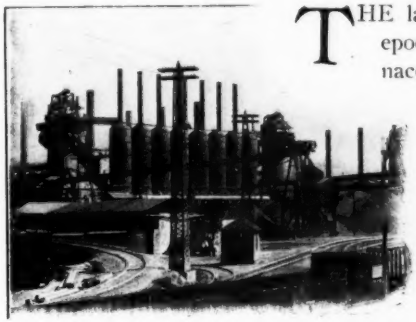
In advocating any system of reform essentials must not be lost sight of, and in this article the aim has been to describe the "fittest" to fill the ranks of industry. The environment at present existing is no adamantine one; the remedies are at hand and only strenuous persistence is needed to carry them through.

Of the many outlets for reform I have noticed only three—reform of workshop, home, education, the preparation for industrial life, and inherent reform in the workman himself. One is reluctantly compelled to admit that reform in the last case is the most urgent and will be most difficult of achievement. This will be effected chiefly by the influence of the recruits. Trained in the use of their faculties as already indicated, their entrance into the industrial masses would in course of time gradually leaven the whole. Such a revolution is a necessary factor in the progress of the nation, and if Britain means to maintain her position as a paramount power, she must sweep away much conservative tradition and educate alike workman and employer to a full sense of responsibility and duty.

MODERN IRON BLAST-FURNACE PRACTICE.

By Frank Hearne Crockard.

Mr. Crockard's article, based largely on American practice, is particularly interesting in view of Mr. Phillips' recent full review in these pages of British iron and steel making and American and German competition. Supplementing Mr. Hatch's description of the transportation methods evolved in connection with the movement of ores from the region of the Great Lakes, Mr. Crockard follows the handling of the crude materials from the stockyards to the furnace, and through it to the finished pig. It is a remarkable study in the application of machinery to meeting the ever-growing demand for more iron and cheaper iron—a demand which the rapid extension of machinery and mechanical methods everywhere has itself created. —THE EDITORS.



THE last three decades have been epochal in American blast-furnace practice and construction. The Lucy furnace of Pittsburg may be named as the primordial furnace of the present type. This furnace in the year 1878 had a cubic capacity of 15,400 feet, and was driven at the rate of 16,000 cubic feet of air per minute. The results of the first year showed a daily production of 91 tons, so that each ton of iron required 169 cubic feet of furnace volume. The coke consumption during this period averaged 2,850 pounds per ton of iron. The promising bud of siderurgical progress thus started reserved a later day for blossoming, and this we find in the Edgar Thomson furnace "blown in" during April, 1880. Furnace B of this group (Figure 1) was 80 feet high, and contained 17,868 cubic feet. The hearth measured 11 feet in diameter and was fitted with eight 5½-inch bronze tuyeres, through which were forced 30,000 cubic feet of air per minute, at a temperature averaging 1,100 degrees Fahrenheit. This furnace produced 132 tons daily, requiring 135 cubic feet of furnace volume per ton of iron. The coke consumption during this period averaged 2,859 pounds. Small as they now seem, these tonnage records were regarded as phenomenal, if not incredible. This period was distinctively, therefore, one of rapid driving, wonderful production, and high fuel, and so continued until the blowing in of the

North Chicago Rolling Mill Company's Number 7 furnace. (Figure 4). This furnace was blown in during March, 1885; for the period covering the last six months of that year the production aggregated 36,680 tons, the average coke for the same period falling to 1,912 pounds per ton of iron; the rate of driving, which averaged from 22,000 to 25,000 cubic feet of air per minute the previous year, had now fallen to 16,000 cubic feet. This achievement marked the next important step, characterizing the period as one of great production, low fuel, and slow driving. While these results were very gratifying, they proved merely precursory of the greater achievements of the new epoch which has since been seemingly resolved into an interminable era.

In September, 1889, the Edgar Thomson group again forged to the front with the blowing in of an 80-foot stack, containing 18,200 cubic feet (Figure 2). This furnace had seven 6-inch tuyeres delivering 25,000 cubic feet of air per minute—a return to the figures of 1880, but productive of entirely different results. The temperature of the entering blast remained about the same, 1,100 degrees Fahrenheit but the pressure had reached 9½ pounds, while the output (for the month of April, 1890) reached 10,075 tons on a coke consumption of 1,884 pounds. In 1880, 135 cubic feet of furnace volume were required per ton of product; in 1890, this figure had fallen to less than 60 cubic feet. Intensity of production was the order of the day, and, thanks to the daring initiative of American metallurgists, has not yet found its prescribed limits.

An interesting example of recent furnace construction is found in the Youngstown plant of the National Steel Co.

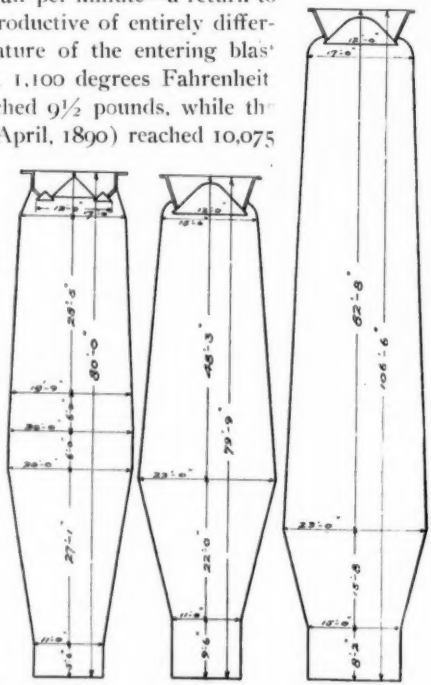


FIG. 1. FIG. 2. FIG 3.

These furnaces are 106½ feet high, 23 feet in the bosh, and have a hearth diameter of 15 feet, giving a capacity of 26,500 cubic feet (Figure 3). Blast at the rate of 50,000 to 60,000 cubic feet per minute is introduced through sixteen 6-inch tuyeres. The normal pressure is about 15 pounds, but the blowing equipment is designed to furnish 25 pounds when necessary. These furnaces were blown in during 1900; in the month of October of that year one furnace produced 17,600 tons with a fuel consumption of 1,777 pounds per ton; a second stack during the same period produced 17,412 tons with a fuel consumption of 1,790 pounds. Both furnaces lost a day during the month. Comment on these magnificent figures is not necessary.*

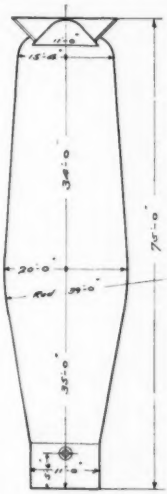


FIG. 4.

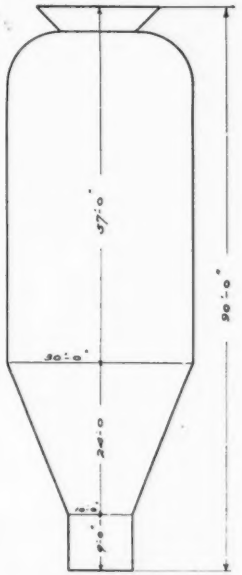
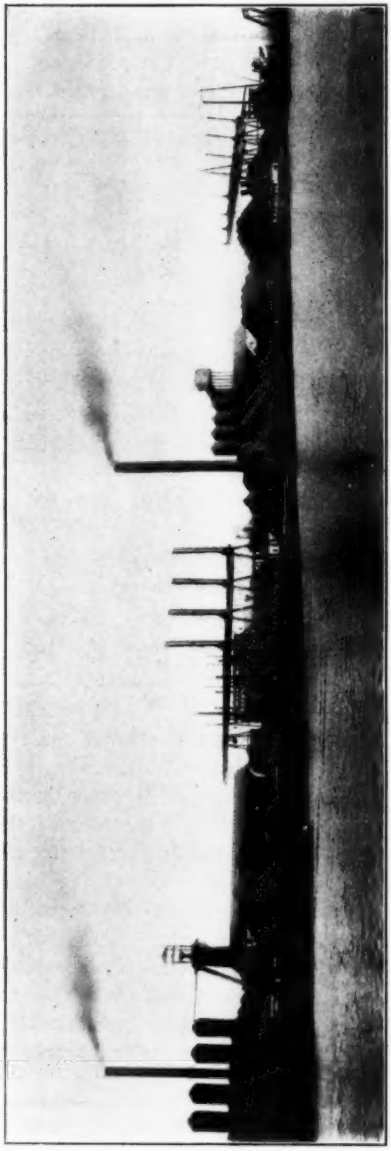


FIG. 5.

While it is true that furnaces of greater (cubic) capacity than the present American furnaces were constructed as early as 1870, as for example the two Ormesby (English) furnaces constructed about that period, which are represented in Figure 5, which had a volume of about 40,000 cubic feet, as compared with 26,500 cubic feet in the case of the Youngstown furnaces, we find their weekly output equalled by the daily product of the latter. The development, then, of the high-pressure, high-tonnage furnace, as we understand the term to-day, has been accomplished during the last ten years. With this increased tonnage, the demand—or rather, the necessity—for apparatus supplementing or displacing manual labor grew apace. When we remember that the digestive capacity of one of these monsters, expressed in tons, approximates 2,000 tons daily, the task of supplying

* Since writing this article one of the Carrie furnaces at Rankine, Pa., has established a new world's record by producing 780 tons for a day's work; as this is a new furnace we may expect to hear of the 800-ton mark being exceeded shortly.—F. H. C.



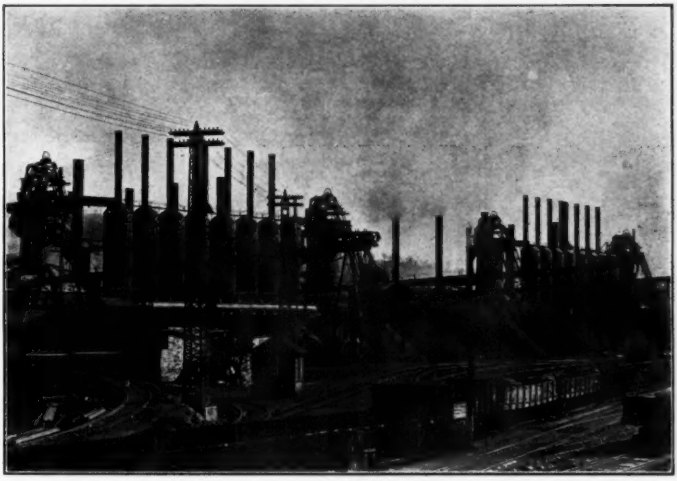
GENERAL VIEW OF THE PLANT OF THE IROQUOIS IRON COMPANY, CHICAGO.

its capacious maw is more fully appreciated.

The Duquesne plant of the Carnegie Steel Co. was one of the first examples of this type. A 600,000-ton stock yard, 1,085 feet long, having an effective width of 226 feet, was provided for the four furnaces comprising this group. The stock yard is spanned by three bridge cranes built by the Brown Hoisting Machinery Co. of Cleveland. During the stocking season, hopper-bottom cars are unloaded in bins behind the ore piles seen in the photograph on the opposite page. These bins form one of two parallel rows; the row nearer the furnaces is used for supplying immediate demands, while the row facing the stock pile is used for transferring the ore from the cars to the ore buckets, which when filled are picked up by the crane and automatically dumped on the stock piles. The reverse operation is accomplished by means of 5-ton drag buckets, which pick up the ore from the face of the pile, delivering it either into the bins or bin-filling cars as may be desired. The cars so loaded are then placed over the

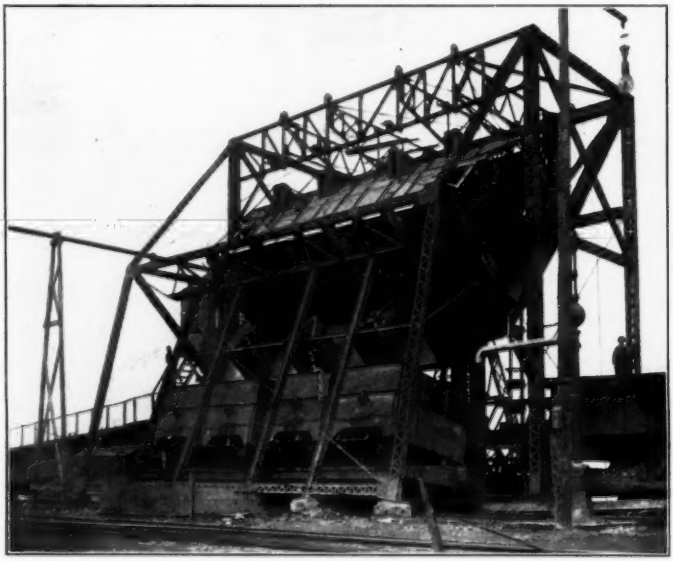
HULETT ORE BRIDGE, NATIONAL STEEL COMPANY'S PLANT, YOUNGSTOWN, OHIO.
Webster, Camp & Lane Machine Co.

proper bins and there unloaded—the bottoms dropped. A more recent plan is that adopted at Neville Island, Mingo Junction, and Youngstown. The photograph just above shows a Hulett ore bridge as built

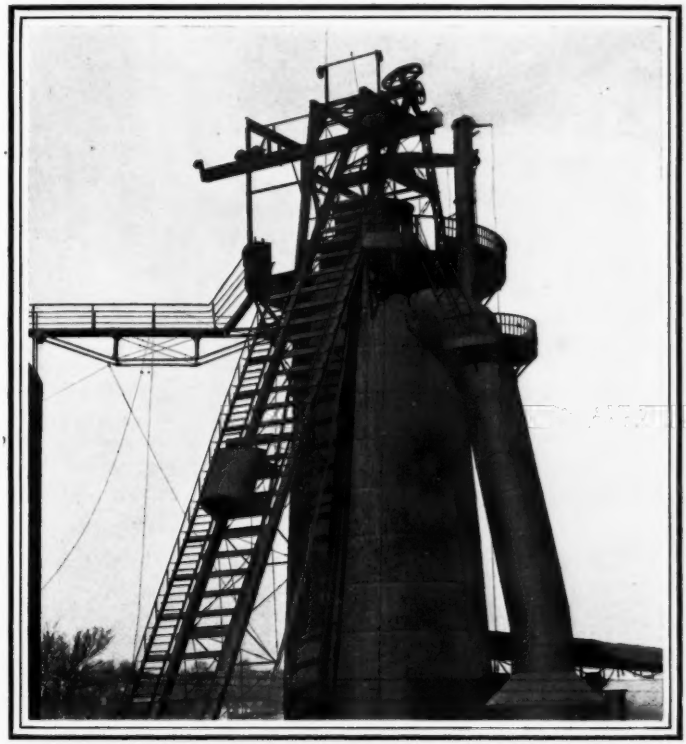


DUQUESNE BLAST FURNACES, CARNEGIE STEEL COMPANY, CAPACITY 800,000 TONS ANNUALLY.
The ore bridges are shown in the foreground.

by Webster, Camp & Lane, of Akron, Ohio. The clear span is 260 feet, with a cantilever extension of 41 feet commanding the ore bins. The method of handling the ore with this system may be briefly outlined as follows: The ore car, which may be either gondola or hopper, is placed on the dumping machine, shown below; when in position, the car is rotated through an arc sufficient to cause a free flow of the ore, which in passing through the chutes is deflected into four side-dumping bridge cars mounted on a transfer car as shown. These bridge cars have a capacity of 17 to 20 tons, and the car dumper will easily handle 15 cars of ore hourly. The transfer car is then moved under the machinery tower of the conveyor bridge, where by means of a cable the bridge cars are pulled up on one of four converging tracks to the through bridge track and automatically dumped at any desired point, either in the stock yard or furnace bins. In taking ore from the stock pile to the bins or bin-filling cars two methods may be used, and in both cases the buckets are operated by the motors operating the bridge cars. A second track, suspended below the main track, carries a trolley to which is attached a scraper bucket (as at Duquesne) holding about 10 tons:



HULETT CAR-DUMPING MACHINE, FOR HANDLING FULL CARLOADS OF ORE. NATIONAL STEEL COMPANY'S PLANT, YOUNGSTOWN, OHIO.
Built by Webster, Camp & Lane Co., Akron, Ohio.



FURNACE-TOP CHARGING APPARATUS.
Built by Brown Hoisting Machinery Co.

about 15 buckets per hour can be taken from the pile to the bin-filling cars. In the second method, a two-part grapple bucket holding about 12,000 pounds of ore is used; 25 to 30 buckets are handled hourly by this arrangement. As the bucket operates vertically, it has the advantage of working in the centre of the ore pile, where trouble from the frost will be less than working on the outside of the pile. The cost of transferring ore from the cars to the stock pile with the Hulett bridge is said to be less than one cent per ton.

The ore now being in stock, the next step is to get it to the furnace. In the case of the larger furnaces the vertical hoist tower carrying its cumbersome charging barrows was found to be a slow and costly method and has been superseded by the skip-way or incline. The ore train, handled by a small locomotive running on tracks placed be-

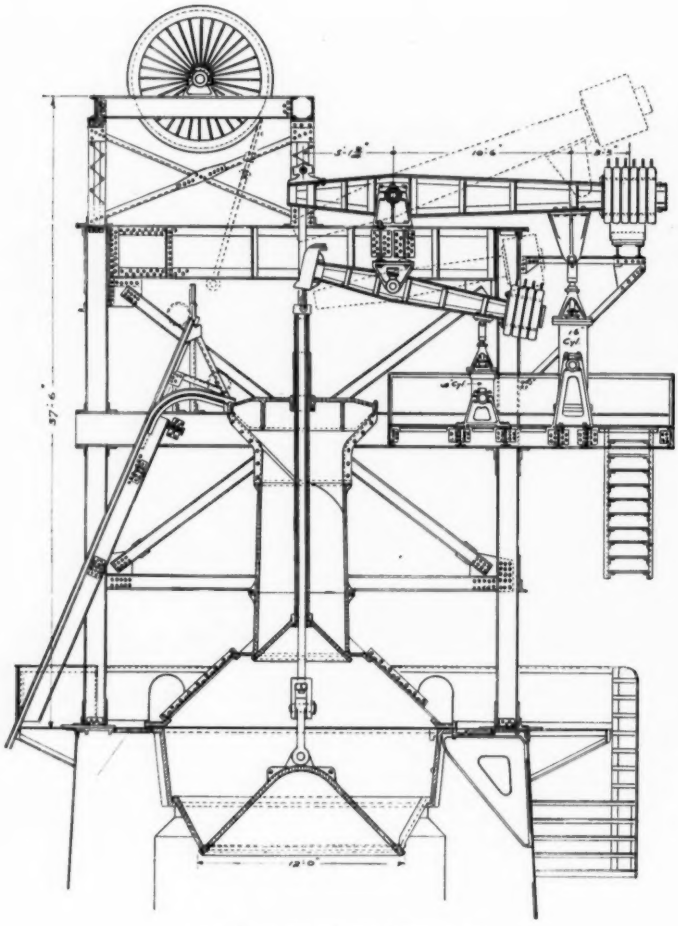
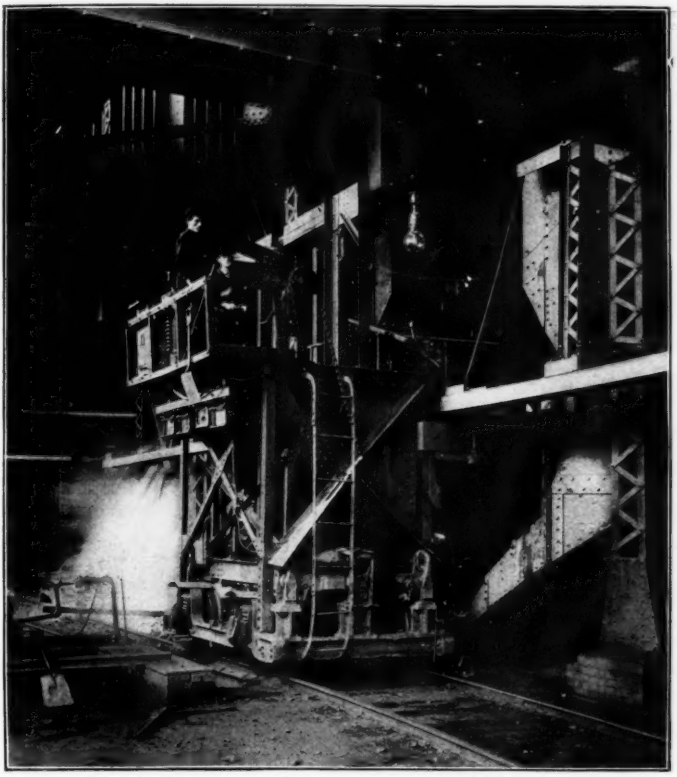


FIG. 6. FURNACE-TOP MECHANISM.

tween the ore bins, is made up of special cars, each of which carries a charging scale, on which rests the ore bucket capable of holding 10,000 pounds of ore. These buckets, when properly filled with the required kinds and quantities of ore, are pushed under the incline. The central bucket rod, pendant from which is an iron cone or bell closing the bottom of the bucket, is now grasped by a bifurcated hook hanging from the incline carriage; from this point they are

rapidly carried to the furnace top and there quickly emptied by lowering the bell forming the bottom of the bucket. This very ingenious arrangement is in use only at Duquesne; possibly a more typical furnace top is that in use at the Youngstown furnaces, shown in



ELECTRICALLY OPERATED SKIP-FILLING OR SCALE CAR, NATIONAL STEEL WORKS, YOUNGSTOWN, OHIO.

cross section in Figure 6. Before considering the top, however, let us first take up the method of assembling the burden. In the photograph just above is shown the skip-filling car, which commands the full length of the ore bins. As will be noticed, it is a side-dumping car electrically operated and carrying its own scales. This car delivers the ore from the bins directly to the skip car, which rests in a watertight tank immediately in front of the car. The limestone is delivered

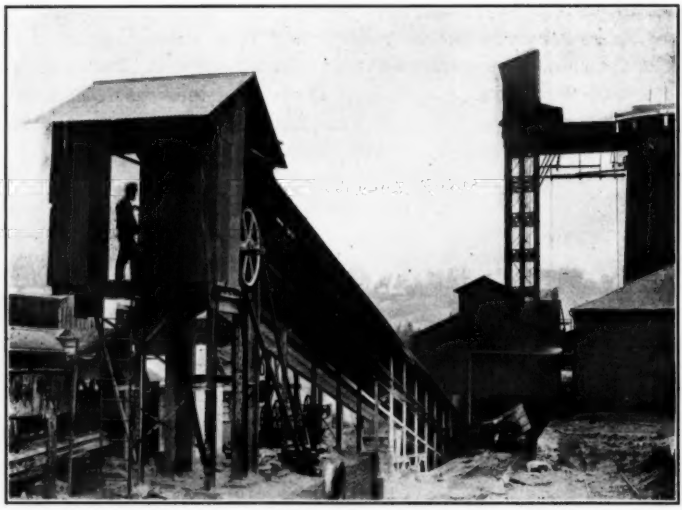
FURNACE NO. 2, WARWICK IRON & STEEL CO., POTTSTOWN, PA.

Showing skipway and furnace top. This top is similar to that shown in the general view of the Jones & Laughlins plant.

from the bin shown to the right directly into the skip car, while the coke is also delivered directly into the skip from the bin shown to the left. The skip, holding about 15,000 pounds of ore, is now carried to the top of the furnace where it is discharged into the receiving or supplementary hopper which is designed to hold a skip load. The small bell closing this hopper is now lowered by means of the 14-inch oscillating cylinder actuating a counter-weighted beam; the descending column of ore is evenly distributed around the main furnace hopper, which holds a 30,000-pound ore charge; this bell is operated by the

FURNACES OF THE WOODSTOCK IRON WORKS, ANNISTON, ALA.

16-inch cylinder. It will be observed that the bell rod of the small bell is hollow and through it passes the solid rod of the large bell. In operating this arrangement the upper bell is always closed during the period the lower bell is discharging stock into the furnace: the seal so formed prevents the waste of the furnace gases. The view on page 499 shows another top charging apparatus, as built by the Brown Hoisting Machinery Co. In this case the skip dumps into a central receiving hopper carrying an inclined spout, which delivers the ore at any given point on the periphery of the bell: as successive charges are dumped into this receiving hopper, it is caused to rotate through any desired angle. It is evident that a furnace charged in this manner closely approaches the hand-filled furnace so far as fa-



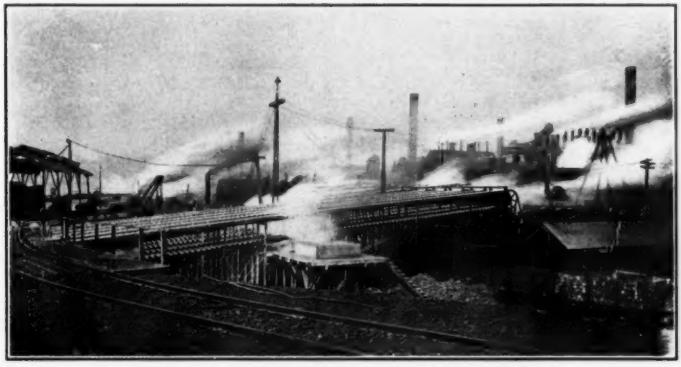
UEHLING CASTING MACHINE, DISCHARGING END, STRUTHERS FURNACE, OHIO.

The pigs, falling from the upper end of the strand, drop into the chute below the figure of the operative, and thence into the water tank. The ladle is shown in pouring position at the lower end.

TOP VIEW OF MOULDS, UEHLING CASTING MACHINE, CARRIE FURNACE, RANKINE, PA.

cility of controlling stock distribution on the bell is concerned. Skips are operated by steam or electricity; in either case an automatic slowing device is used which causes the skip to come to rest gradually and without shock.

Another interesting part of the equipment of the modern blast furnace is the casting machine. In dealing with the heavy tonnage involved it was found necessary to have a quicker and more reliable, as well as a cheaper and less laborious, method of handling the iron than that afforded by the old system of casting in pig beds. To meet this demand several well-known machines have been devised, one of which, the Uehling, is shown in the photograph as built by the American Casting Machine Co., at the Edgar Thomson works. The pigs weigh from 110 to 115 pounds, and being free from sand are much more acceptable than the sand-laden pigs of our fore-fathers.



UEHLING CASTING MACHINE AT THE EDGAR THOMSON WORKS.

Slag machines of the Hawdon type have also been installed in several plants where the local conditions seemed to warrant this particular method of slag disposal. As long as the slag dump affords sufficient room, the ladle car will likely continue as the cheapest and quickest method of disposing of what is still very largely a waste product. In this connection it is interesting to note that several furnace plants, notably the Illinois Steel Co., are making a high-grade Portland cement from their furnace slag.

Another feature of the modern furnace deserving special mention is the water-cooled bosh plate. As late as 1890 we could not point to a single furnace which had produced 250,000 tons during the life of a lining; to-day we have records exceeding 1,000,000 tons. Early ex-

periments with water-cooled cast-iron plates built into the bosh walls demonstrated the efficiency of this method of preserving bosh walls. These iron blocks were, however, rather difficult to replace when making renewals, and as a result of continued efforts toward improvement along these lines we have to-day several well-known forms of

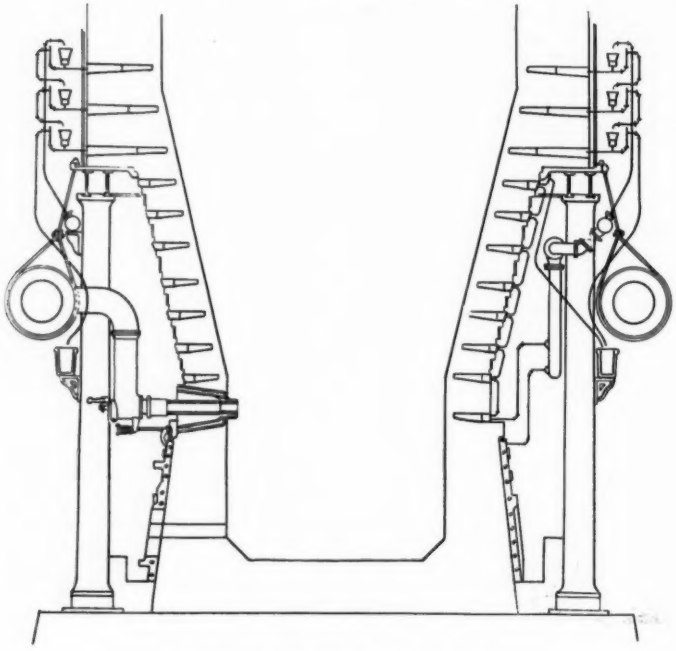
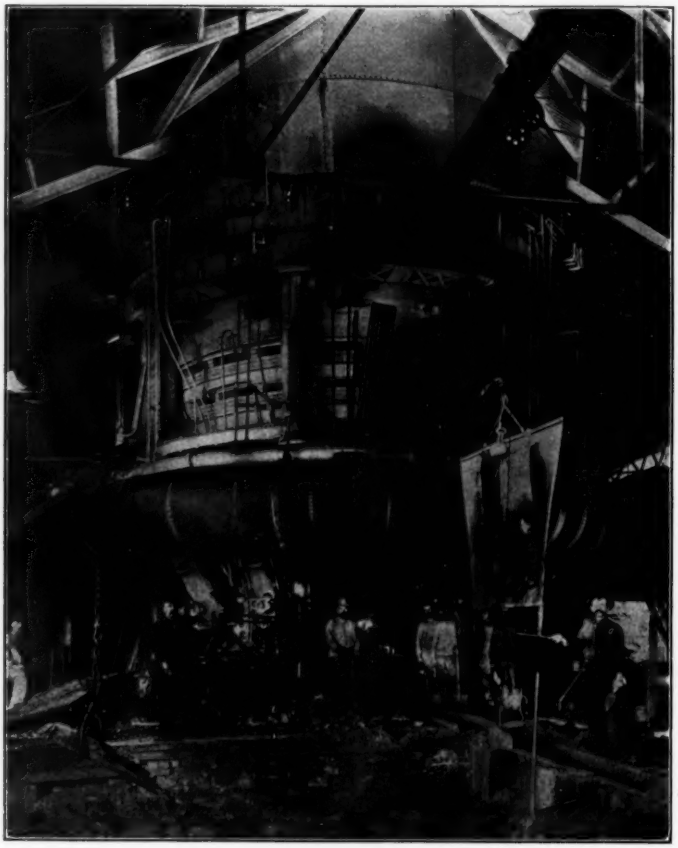


FIG. 7. WATER-COOLED BOSH WALLS.

bronze or copper bosh plates, which are built into the bosh walls as shown in Figure 7. In the case of the well-known Scott plate they are built into the walls with a relieving arch of brick thrown over each plate. In other cases, as with the Gayley, these arches are dispensed with. In more recent practice an iron arch or socket plate which acts as a holder for the water block has been adopted. The large plates formerly used have given way to a greater number of smaller plates; the total amount of copper in a given furnace is not increased by this arrangement, but a more thoroughly protected bosh is the result. At the tuyere belt these plates are placed a minimum distance apart (vertically) usually just far enough to allow the proper space for the thick-

HOT-METAL BRIDGE AND 600,000-TON STOCK YARD, JONES & LAUGHLINS, PITTSBURG.

Steam shovels load the ore from stock pile into hopper-bottom cars which deliver the ore to the furnace bins as required.



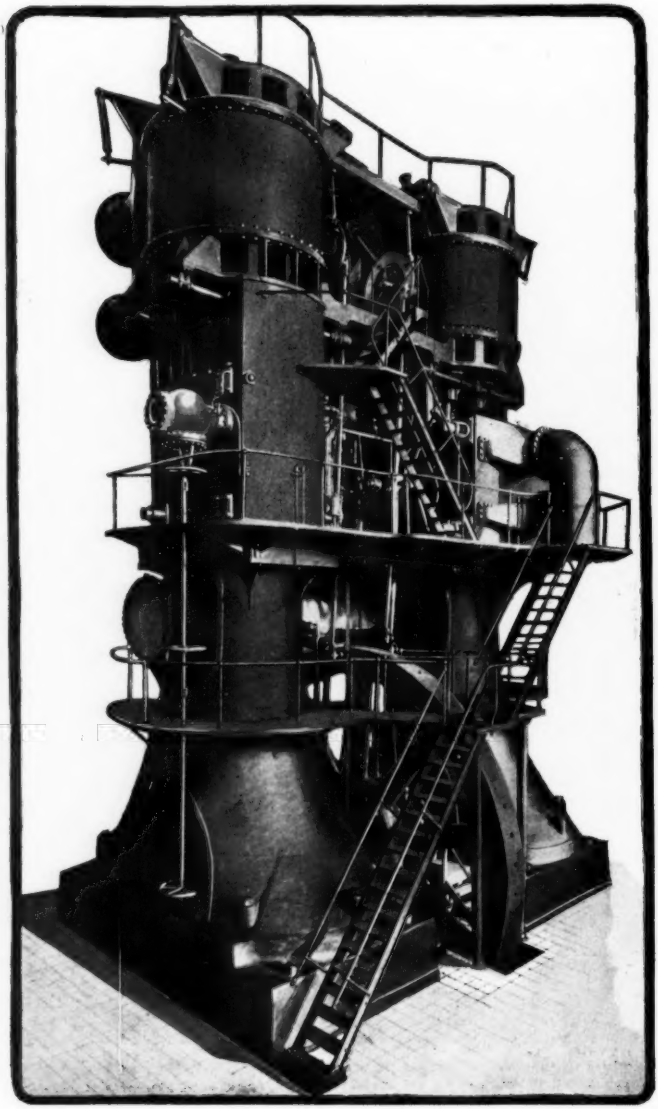
FRONT VIEW OF NO. 3 FURNACE, LEBANON, PA., SHOWING ARRANGEMENT OF BOSH PLATES.

ness of the socket plates and the depth of the bosh bands. As we leave this region of intense heat and approach the top of the bosh, the plates are gradually spaced farther apart. A circular feed line carrying water at 10 to 30 pounds pressure supplies the legs or manifolds placed at each column (Figure 7). The water is conducted from these manifolds to the lowest row of plates and allowed to ascend through the series, finally discharging into the water trough. Above the mantle plate it is desirable to use a gravity feed instead of pressure; the idea is clearly shown in the sketch. The hearth is protected by a

heavy steel jacket cooled by a water spray, or a cast-iron jacket built up in sections each of which carries a coil of pipe through which the cooling water circulates. With the increased bosh life it was found necessary to protect the brick work forming the throat of the

FRONT VIEW NO. 3 FURNACE, JONES & LAUGHLINS.
The Vaughn notch-gun is seen hanging from a crane.

furnace in order that both top and bottom might "die" together. In some instances water-cooled blocks have been used for this purpose, but this seems a needless refinement, since a series of cast-iron plates

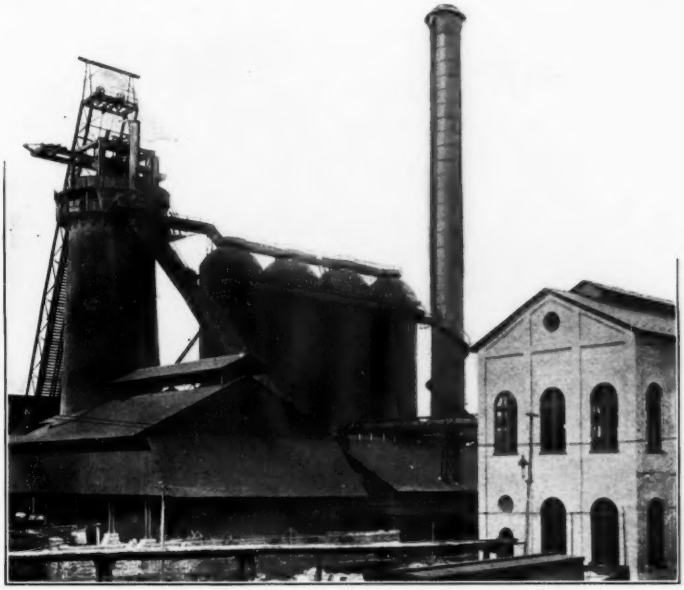


VERTICAL STEEPLE CROSS-COMPOUND BLOWING ENGINE, NATIONAL STEEL CO., YOUNGSTOWN, OHIO.

Cylinders 54, 102, 108, and 108 inches by 60 inches. Capacity 60,000 cubic feet of free air per minute. Weight 635 tons. Built by The Wm. Tod Company, Youngstown, Ohio.

properly arranged will furnish all needed protection for this portion of the furnace.

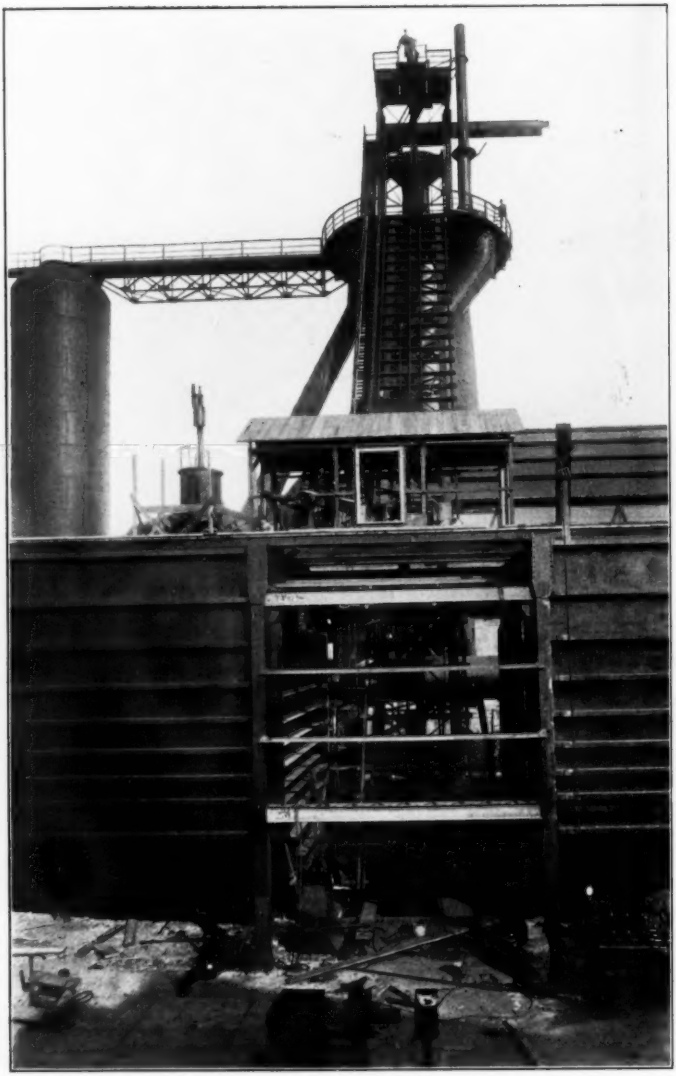
The scope of this article will scarcely permit more than a reference to the hot-blast stoves of the modern furnace; with these the evolutionary process has been chiefly one affecting size rather than one



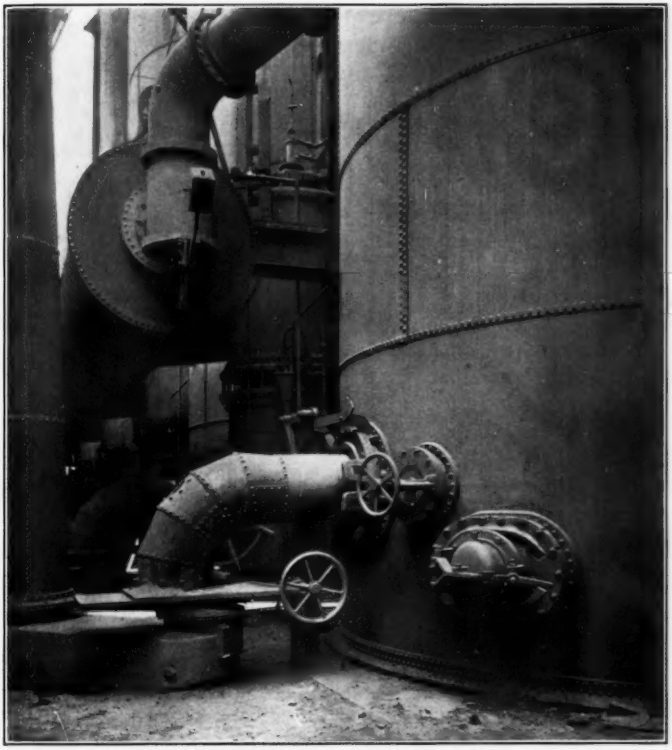
WARWICK IRON & STEEL COMPANY'S NO. 2 FURNACE.
Showing back view of skipway, grouping of stoves, boiler house, and engine room.

causing any radical changes in former well-known designs of the regenerative type. Some of the recent stoves have been built 21 feet in diameter and 118 feet high..

In the case of the modern blowing engine we find the poppet, slide, and piston valves of the steam cylinder replaced by the Corliss. The modern engines are of the vertical cross-compound condensing type, as shown in the photograph which represents the Tod engine built for the National Steel Co. The diameter of the high-pressure cylinder of these engines is 54 inches, that of the low 102 inches, giving a volumetric ratio of 3.57. The air cylinders, which are tandem to and above the steam cylinders, are 108 inches in diameter; the common stroke is 60 inches. At 160-pounds steam pressure and 26-inches vacuum, these engines will develop 5,000 indicated horse power when



ONE OF THE FURNACES OF THE IROQUOIS IRON COMPANY, CHICAGO, SHOWING SKIPWAY.



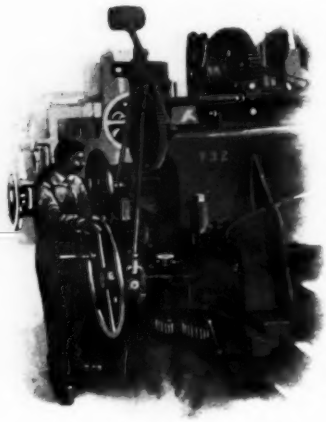
VIEW SHOWING GAS WASHER, GAS BURNER, AND REMOVABLE HOT BLAST VALVES, MASSICK & COOKES' THREE-PASS STOVES, JONES & LAUGHLINS, PITTSBURG.

running at 45 revolutions, and deliver 57,000 cubic feet of free air per minute at 25-pounds pressure per square inch. The weight of these engines is about 635 tons each. In this connection it is to be regretted that the internal-combustion engine, using furnace gases, has not yet found its way into American plants even experimentally. The barbarous practice of developing power by means of the steam boiler continues as the accepted method. From an economic point of view this subject offers a most attractive field, and it is to be hoped that the next epoch in blast-furnace practice will record achievements as successful along these lines as those briefly chronicled in this incomplete *résumé* of modern blast-furnace practice.

NEGLECTED FACTORS IN MACHINE-SHOP ECONOMICS.

By T. S. Bentley.

Mr. Bentley's discussion, like Mr. Longmuir's preceding, is inspired by the rapid increase in the pressure of competition arising from the extension of trade to an international range. But while Mr. Longmuir goes back to the deep-lying sociological causes influencing the quality and capacity of the working class, Mr. Bentley deals directly with matters of management and equipment affecting the quality of the work, but within the immediate province of the employer. The papers supplement one another as propositions for British workshop reform, one treating of the human elements, the other of the mechanical elements in the problem.—THE EDITORS.



AT the present time, when the subject of foreign competition looms so large across the industrial horizon of Great Britain, all points bearing on the comparative cost of production attract universal attention and demand the most careful consideration of British manufacturers.

A number of years spent in close touch with machine shops, and keen observation from points of view both within and without, have convinced me that there are numberless causes of waste and leakage which commonly pass unrecognised, or, where not entirely ignored, are apt to be so grossly under-rated as to be thought of very little account.

There is nothing new about the facts themselves. They are well-known to those connected with machine shops—indeed, it is their very familiarity that frequently leads to their being passed over without a thought. The workmen who are the most directly affected have no power and no special incentive to attempt a remedy, and are not always encouraged to make suggestions regarding affairs which concern the management. The employers, on the other hand, are usually not in a position to gauge with accuracy the effect of these small matters. While there undoubtedly are shops where individual points are noted and remedied, they are merely the "exceptions that prove the rule."

The suitability of the workshop for its special purpose has an

effect which cannot easily be overestimated. In many instances this factor alone will practically settle the question of manufacturing success or failure. When a workshop is built with a particular end in view its suitability can be insured, but frequently a building designed for some entirely different purpose is converted into a workshop, in which case—as with all makeshifts—it is uncertain how far the result will be satisfactory.

The lighting in such cases is often woefully deficient, and as a consequence the work suffers both in quantity and quality. No workman can do justice either to himself or his employer if the light by which he works be poor. Artificial illumination is far less satisfactory than daylight, and at the same time adds a considerable amount to the working expenses of the shop. While referring to light it may be well to hint that pounds could often be saved on the gas bill or electric-light account by a trifle more being expended on window cleaning and whitewashing. Much valuable time also is wasted in groping around in a bad light after tools, etc., which should be in full view and ready to hand. The loss due to these few items is not easily realised by anyone who has not worked under such conditions.

The proper heating of the workshop is another point which is usually treated as of but little importance. It is even argued that a cold shop conduces to increased activity and application on the part of the workmen, and is therefore rather an advantage by providing a useful stimulus. No greater fallacy than this was ever uttered. The work in a modern manufacturing shop seldom entails sufficient quick active movement to neutralise the numbing action of a chilly shop filled with ice-cold machinery. The vital heat is therefore sapped from the workmen till the marked disparity of temperature is reduced. Such a shop has a human heating apparatus, which cannot be economical as long as it pays to employ men to hew coal. A shivering man grasps his tools with an uncertain hand and the work he does is scanty and poor. I am convinced that the effect of this during the hours before breakfast is so great that it would often pay to dispense with the "morning quarter" during the winter months.

It is often thought that under the piece-work system these matters merely affect the personal comfort of the workman, and have no place in a strictly economic view. In reality it makes no difference whether the worker is rated by piece or by time. The ultimate standard on which all systems of payment are based is the average output of required quality with the appliances available and under existing conditions of work. The elaborate systems of heating recently introduced

into modern factories (notably in America) show that in some quarters the importance of the subject is recognised.

It is a short step from the workshop to its equipment, but it brings us at once to a vital difference in aim and range which divides shops roughly into two classes—the jobbing shop and the factory. In the former both new work and repairs of many kinds and sizes are taken in hand, the various cases being treated individually. Such shops are indispensable under existing circumstances, but are poorly adapted to meet modern manufacturing competition. In their equipment, range and adaptability have been given a foremost place, while to obtain the best results in any given direction these qualities must be sacrificed.

In the class with which we are just now chiefly concerned we have the factory devoted to a particular style of work within fixed limits as to size and kind. It is shops like these that "set the pace" for the world and they can only be equalled by similar concentration. We are proud of British achievements in the industrial world and of the reputation they have earned. If reputation results in diminution of effort, however, it will prove a disastrous legacy. Our foreign competitors are pressing us more closely than ever and we must disencumber ourselves of every hindrance if we are to hold our own in the race. Many of our manufacturing concerns would secure a greater measure of success if they curtailed somewhat the variety of their undertakings and thus concentrated their energies within a narrower compass. It is suggestive to notice how many advertisements, especially in contemporary American trade journals, if stripped of their descriptive technicalities are reduced to the old formula "This one thing I do." Nothing could indicate more clearly how much weight is attached to this point by many of our most formidable rivals. The pronouncement of an expert will always outweigh the opinion of an all-around man, however well informed he may be, and whether the science involved be miltary, legal, or any other. The reasoning that is admitted and acted on in these cases applies with no less force to mechanical subjects, and is equally as true when applied to a combination of experts as to one individual. The fact that it is possible to obtain the highest results in a variety of directions if the concern be of sufficient magnitude in no way affects the main contention. In such cases each department is usually so far distinct that the result is equivalent to a collection of specialised shops financed from a common source. This is exemplified by a number of large "combines" of recent years, in which the factories concerned have frequently been a considerable distance apart and have continued to retain many of their original characteristics.

When the style and range of work has been decided on, the next thing is to select the most efficient plant for producing it. The equipment of a workshop should bear so direct a relationship to the manufacture undertaken as to make the two ideas practically inseparable. Many shops are now engaged in the hopeless attempt to hold their own against keen competition by means of appliances quite unsuited to the needs of the case. Others are striving to keep up with the crowd by the aid of machinery that is obsolete and half worn-out. Such concerns are beaten before they begin. That this state of things exists cannot be gainsaid, and the fact speaks far better for the pluck of those concerned than for their perception or alertness. It is now universally recognised that in the matter of military equipment, to be behindhand and out of date is to court disaster; and the same principle applies with equal force to all industrial questions. To carry the analogy still further, it is never expected that military machinery shall be worn out, but that it must be replaced as soon as improvement threatens to render it obsolete. In a similar way those who in the struggle of manufacturing competition neglect to keep pace with the developments made from time to time in methods and appliances, will inevitably be outstripped by their more enterprising contemporaries. There are notable instances of firms throwing out expensive and almost new machinery in order to adopt a later style, and the results have been in most cases conspicuously advantageous. Naturally the first result of a change of this kind is a seeming loss. This is rapidly repaid by increased output and reduced cost of manufacture, and as soon as the initial outlay is covered the advantage secured becomes pure profit.

In the natural endeavour to secure the best results by the selection of the most suitable plant, discrimination must be used or our object will not be attained. It must ever be borne in mind that the scope of a machine cannot be extended without its efficiency in particular cases being impaired. The converse, however, is equally true, and it must be remembered also that a design calculated to give the maximum result in any one direction is inevitably circumscribed in range. This is a mechanical law from which there is no escape, and to which we incidentally referred when urging that the work undertaken should be kept within reasonably narrow limits as to size, etc. Theoretically, everyone believes in specialised machinery; in practice it is not so universally appreciated. The shop foreman cannot be expected to be enthusiastic over it, as the apportioning of work becomes a matter of far more difficulty if all the machines are to be kept constantly employed. It is probable that this factor accounts in great measure for

the abundance of long-gap-bed lathes to be seen in English workshops. Many of them are continually used on short ordinary work so that their adaptability is not required, and it is often forgotten that all their work is handicapped by their structural defects and the valuable shop room that they uselessly occupy. Much is forgiven them, however, for the way they simplify work distribution; but it is a question how far this compensates for the other points mentioned.

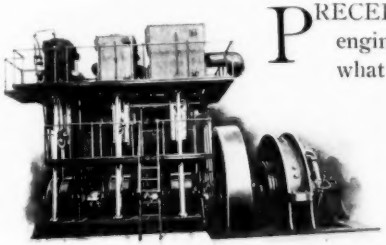
The subject of patterns and designs is one about which much might be said, but I shall briefly touch on one or two points. In any design the first object aimed at undoubtedly should be efficiency, but ease and cheapness of production must never be forgotten. It frequently happens that the draughtsman who works out a design has had no experience of actual shop practice to guide him, and in other cases he is out of touch—if not out of sympathy—with the shop. Unless the designs of such a one are carefully checked by a thoroughly practical man before being finally passed in, difficulty and expense of manufacture may easily be doubled. Sometimes the pattern maker or moulder finds his difficulties increased by reason of some awkward form of doubtful benefit. The machine-shop foreman often has to worry over a needlessly troublesome task; or one perhaps practicable in itself but formidable in the light of the appliances at his command. A plan for the avoidance of this kind of thing has been tried with success in some of the most progressive factories in the United States, in accordance with which the foremen, draughtsmen, and head of departments meet together to discuss the details of any new work that may be coming forward. This not only saves much loss and annoyance due to such little points as have been mentioned, but breeds an *esprit de corps* and general good feeling that goes far to insure the satisfactory accomplishment of any work that may be taken in hand.

The cost of raw material is a point on which many firms keep a vigilant eye, and the matter is frequently intrusted to a buyer chosen for his ability to make good contracts and generally to reduce the amount paid for the various stores required. This plan has its undoubted advantages, but loss is sometimes caused where least suspected. It often happens that a slight difference in the quality of material will add two or three hundred per cent. to the cost of machining and then give a worse result in the matter of finish. On many classes of work the value of the raw material is small compared with that of the labour expended on it. In this way a small initial saving may entail a large ultimate loss.

ENGLISH, AMERICAN, AND CONTINENTAL STEAM ENGINEERING.

By Philip Dawson.

Mr. Dawson's articles began in THE ENGINEERING MAGAZINE for November, 1901, and the two preceding papers have discussed British steam engineering and traction plants. Transposing the order of appearance proposed in our last issue, the section on Continental engines appears below, leaving American steam practice for the concluding paper of the series next month.—THE EDITORS.



PRECEDING articles have dealt with steam-engine practice in Britain. As a preface to what is to be said on the subject of Continental steam engineering, a few remarks on the magnificent show of engines at the Paris Exhibition of 1900 are suitable. It will be remembered that the vast amount of electric energy required for driving exhibited machinery, for lighting the palaces and grounds, and for all the miscellaneous purposes of the Exhibition, was generated in the great power station, the Palais de l'Electricité, in which were collected examples of the latest steam-engine and electric-generator practice of almost all the industrial nations. The United States was not represented on the Champ de Mars, and only by a small installation at the Vincennes Annexe, while from Great Britain also the contribution was a very small one. On the other hand, France, Germany, Italy, Switzerland, and Austria combined to make such a central power station as had never before been seen, containing the best work of the leading manufacturers of these countries.

As regards the power station of the Paris Exhibition, England was but very poorly, and the United States was not at all, represented. The Germans occupied the place that should have been ours. There is no doubt but that as a nation we have a fixed, and in many cases, unreasoning belief in ourselves. This is one of our strong points as a nation because by never being willing to acknowledge ourselves beaten, we often get over difficulties and succeed where others would

fail. But this confidence can be pushed to extremes and cause us not to perceive that others are improving whilst we stand still.

Whether the poor show made by Great Britain was due to faulty management or to political or other causes we need not consider here. All foreigners who visited the Exhibition will undoubtedly have gone away with the notion that Great Britain has yielded her supremacy in mechanical and electrical engineering. Such an idea will, of course, be cultivated by all her foreign competitors, and will still further weaken her in foreign markets, where competition is already so severe.

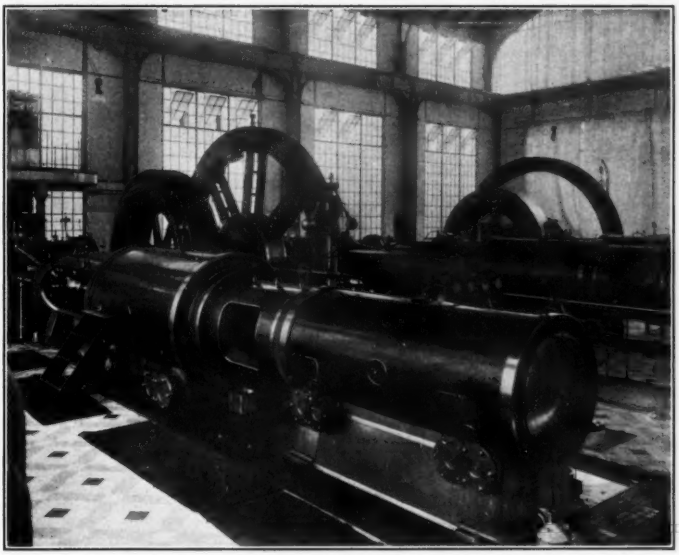
The following remarks upon Continental practice at the present day are based upon the general lines of the engines exhibited at the Paris Exhibition of 1900, and may be taken as fairly representative.

Taking the horizontal engines first, as being more common than the vertical type, it is almost the invariable practice to use trunk beds. The cylinders, although to a certain extent overhung, are rarely entirely so; in fact, they are usually supported at each end by pedestals which form part of the steam chests. In most cases the main plummer block forms part of the bed plate, but in the Dujardin engine and some others it is secured by a faced and bolted joint. The guides for the cross-head are nearly always bored out in circular form. The plummer blocks are generally extremely massive, with cast-iron babbitt-lined steps, but the shafts would seem to be rather on the small side. With regard to cranks, French makers seem to favour crank discs made of cast iron, but otherwise wrought-iron or steel crank arms with heavy balance weights seem to be the usual practice.

In tandem engines the connection between the cylinders usually consists of a large hollow casting. Most of the large engines have the cylinder covers steam-jacketted, and almost all are fitted with vertical air pumps below the ground level. The flywheels as a whole seem to be rather light, and not much attention appears to have been devoted to this point, whilst the construction varies considerably. With regard to cross-head, it is scarcely possible, in view of the numberless varieties which appear to exist, to fix upon any special form and call it standard. Most tandem engines employ some sort of bearing between the cylinders to support the piston rod and prevent wear of the glands. In the big ends of the connecting rods the most usual practice is either the wedge-adjusted solid end or the marine pattern.

With regard to valve gears, there are a very large number of varieties. The Collmann gear is very popular. The type of valve which is characteristic of Continental practice is the "poppet" valve. A trip gear of some sort is practically universal.

Dynamo-electric machinery is of much more uniform type of construction than used to be the case some years ago. Nearly all alternating or polyphase machines have fixed armatures and revolving field magnets, the latter in many cases taking the place of a flywheel. A number of the large polyphase machines seem very heavy for their output when compared with standard American practice. In some

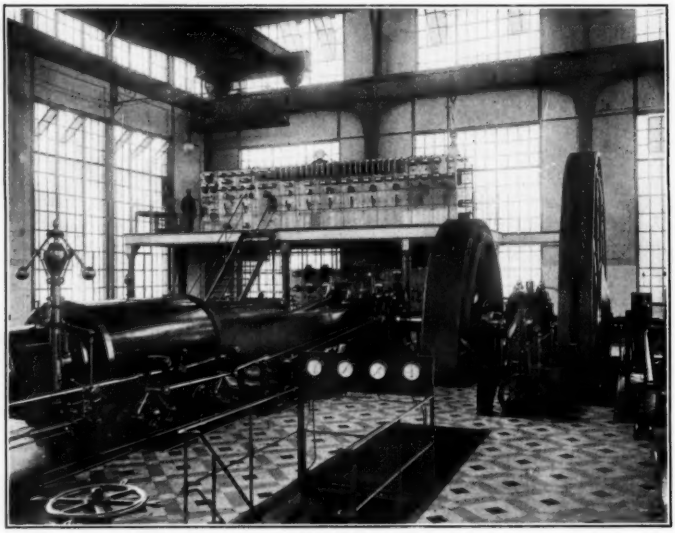


1500-HORSE-POWER FOUR-CYLINDER HORIZONTAL DOUBLE TANDEM ENGINES BY DUJARDIN OF LILLE.
Installed by the French Thomson-Houston Company.

German machines lightness has been pushed to extremes, and in one case tie rods had to be added afterwards.

In most of the continuous-current machines slotted armatures are used. The conductors which connect one commutator bar to the other are generally composed of separate strips soldered together. This method has been given up in America in favour of coils forged out of one piece of copper and having soldered joints only at the commutator. The general practice, as shown at the recent Exhibition, is to drive the exciters directly off the main shaft of the main engine. For large units it would seem preferable to have separate exciting sets, so that anything going wrong with the exciter would not lay up a main generator. Furthermore, small machines, such as exciters, can satisfactorily run at much higher speed than the large main generators.

The method of rating the capacity of generators and steam engines seems to differ from what has been found to be advisable for traction and power purposes where sudden overloads are frequent. The rated capacity is generally the maximum load which a generator can safely carry for several hours. The better way is to have the rated load the one at which the machine runs with the greatest economy.



DUJARDIN ENGINES, ORLÉANS POWER STATION.

Installed by the French Thomson-Houston Company. Four-cylinder horizontal double tandem type. 1,500 horse power.

building the engine and dynamo, however, in such a way that they can, for at least two hours continuously, carry from 25 to 50 per cent. overload without injury, and can momentarily carry from 50 to 100 per cent. overload. It is probably owing to the different method of rating and to the difficulty which many European manufacturers have found in building dynamos which will come up to the above specifications, that storage batteries are used so extensively on the Continent. In this connection a card hung on one of the large continuous-current dynamos stated that one of the great merits of this machine is that it could stand 20 per cent. overload for short periods. This is particularly remarkable, as in all traction specifications which have been issued by competent engineers in Great Britain it is specially stated that the generator shall, for at least two hours, stand overloads vary-

ing from 25 to 50 per cent. without the development of injurious heating or sparking.

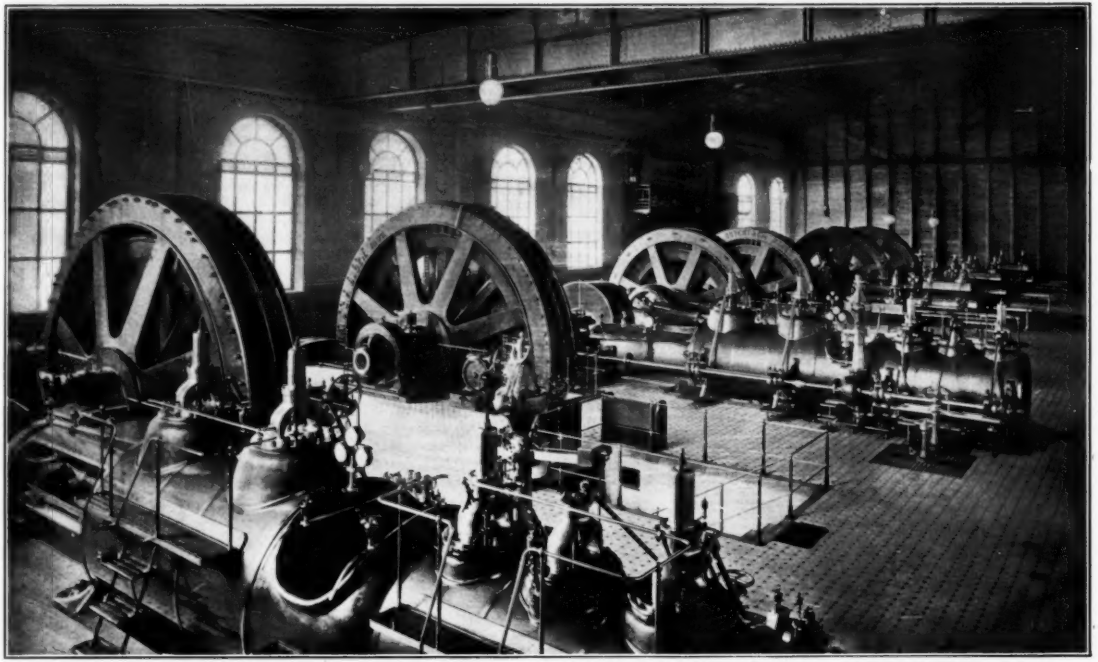
As regards the engines and generators shown in the British section, they were externally not so carefully finished as their foreign neighbours. Many similar engines running in British central stations present a much better external appearance than those shown in the Palais de l'Electricité. This was a pity, and was presumably due to the engines not having been ready in time and having to be rushed through.

Paris Metropolitan Railway; Electric-Power Station. The power station is located at Bercy on the Quai de la Rapée, situated on the bank of the Seine, near the Paris, Lyons, and Mediterranean Railway terminus. As well as furnishing continuous current to the lines, the station is designed to supply three-phase high-tension currents to a sub-station installed under the Place de l'Etoile between the Avenues Hoche and Wagram.

The steam-generating plant consists of thirty-six boilers arranged in three groups of six pairs each. These boilers are of the elephant type, consisting of two horizontal cylindrical bodies joined by three short tubular legs to the upper main cylindrical portion, which is also horizontal, and contains fire tubes. The lower cylinders have a diameter of about 3 feet, that of the upper one being 7 feet 2½ inches. The heating surface of each boiler is 2,626 square feet.

In the engine room there are four 1,500 kilowatt direct-coupled units, the engine being of the two-cylinder cross-compound vertical type, with the generator mounted on the shaft between the cylinders. Both cylinders are provided with four Corliss valves, the cut-off in the high-pressure being regulated by the governor; a special safety governor acts on two balanced slide valves on the high-pressure and low-pressure cylinders. Each cylinder is jacketted with live steam, and there is a reheating receiver.

The cylinders measure 41.34 inches and 70.87 inches by 59.05 inches stroke; the piston rods are 6.67 inches diameter, and the crank pins 13.39 inches diameter. The length of the connecting rod is 11 feet 6 inches. The diameter of the crank shaft in its bearings is 19.29 inches and the length of the bearings is 39.37 inches. There are three main bearings, one at each end, and an intermediate one in the middle of the shaft between the generator and flywheel. The engines were constructed by Messrs. Schneider & Co., and indicate 2,500 horse power when running at 70 revolutions per minute under normal conditions. Continuous automatic lubrication is supplied.



FRANKFORT CORPORATION ELECTRICITY WORKS. FOUR SULZER TANDEM-COMPOUND CONDENSING ENGINES OF 1,500 INDICATED HORSE POWER EACH AND FOUR OF 750 HORSE POWER EACH. ELECTRICAL MACHINERY BY BROWN, BOVERI & CO.

Orléans Railway Extension; Electric-Power Station. The power station is built at Ivry, about three miles from the Quai D'Orsay terminus, and generates high-tension three-phase current; the whole of this plant is by the French Thomson-Houston company.

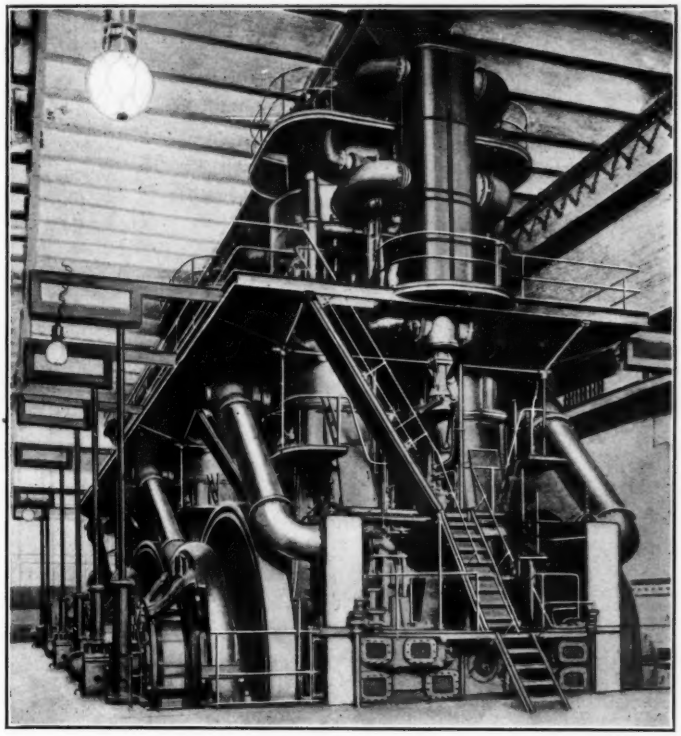
The boiler room contains eight Babcock & Wilcox boilers, arranged in two groups. The heating surface of each boiler is 2,002 square feet; the drums are 3 feet 11 inches in diameter by 23 feet long, and there are ninety tubes 18 feet long and 4 inches diameter. The grate area is 36½ square feet and steam is delivered at a pressure of 185 pounds per square inch. These boilers supply steam to two horizontal triple-expansion four-cylinder Corliss engines, running at 75 revolutions per minute, and giving 1,200 to 1,500 horse power each. There is one high-pressure cylinder 24 inches diameter, one intermediate-pressure cylinder 36¼ inches diameter, and two low-pressure cylinders $41\frac{5}{16}$ inches diameter, and the length of stroke is 65 inches. Steam distribution is effected in each cylinder by four rotary Corliss valves, the cut-off in the high-pressure cylinder being controlled by the governor. All the cylinders are steam-jacketted. The shaft is carried in three bearings, one at each end forming part of the engine frames, and one in the centre of the shaft between the fly-wheel and dynamo. The fly-wheel is 24 feet 7 inches in diameter and is keyed onto the shaft. The builders of the engines are Messrs. Dujardin of Lille. The exhaust steam is dealt with by vertical jet condensers. The air and water are exhausted by two vertical single-acting pumps, driven off the head of the low-pressure connecting rod.

General steam-engine practice is much the same the Continent over. As regards outside appearance, many more parts are polished bright, and in some cases nickel-plated, than is usual in England and all parts are more highly finished. England itself in that respect is much more careful than the United States, and much rougher finish is tolerated there than in Europe. Tandem engines are nearly always used, and triple-expansion even for traction work are generally adopted. In Germany, tandem engines are even put in in the case of vertical engines, or have been till quite recently. When these are not employed the marine type of vertical engine is much liked.

To illustrate this tendency I cannot do better than describe and illustrate the Berlin plants of the "Berliner Elektricitäts Werke" put in by the Allgemeine Elektricitäts Gesellschaft, of Berlin, and the Hamburg works put in by Schuckert Co., of Nürnberg, and the Frankfort station put in by Sulzer and Brown, Boveri & Co. The Berlin

Name of Station.	Year started.	Total capacity at start in Kilowatts.	Total capacity in kilowatts of station in 1900.	Total number and type of boilers, 1899.	Type, number and capacity in indicated horse-power of each steam engine.	How connected to dynamos	Number, type, and capacity of generators.	Remarks.
Markgrafenstrasse	1885	500	3,028	Nine Heine	Six 500 I. H. P. Corliss compound condensing, 82 revs.	Direct.	Six 238 kilowatts, continuous current; three 400 kilowatts, continuous current.	Driven by 3 three-phase motors supplied with power from Schiffbauerdamm.
Mauerstrasse, . .	1886	247½	5,988	Ten Steinmüller.	Two 300 I. H. P. Corliss compound condensing. 82 revs.; four 1,000 I. H. P. Corliss compound condensing, 75 revs.; two 1,500 I.H.P Sulzer compound condensing Bon Jour Corliss. 10 revs.	Direct.	Two 238 kilowatts, continuous current; eight 364 kilowats, continucus current; four 650 kilowatts, continuous current.	Battery of accumulators, 250 volts working pressure, and 6 000 ampere hours in parallel.
Spandauerstrasse.	1889	1,456	7.384	Eight Steinmüller, eight Heine.	Three 1 000 I. H. P. Corliss compound condensing. 70 revs.; one 1,500 I. P. H. Corliss compound condensing, 70 revs.; three 1.500 I.H.P. Sulzer compound condensing, 105 revs.	Direct.	Six 364 kilowatts, continuous current; two 650 kilowatts, continuous current; six 650 kilowatts, continuous current.	Battery of accumulators, 250 volts, working pressure, 6,000 ampere hours in parallel.
Schiffbauerdamm.	1890	728	4,984	Eleven Steinmüller.	Three 1.000 I.H.P. Corliss compound condensing, 70 revs.; two 1.500 I.H.P. Collmann compound condensing, 105 revs.	Direct.	Six 364 kilowatts, continuous current; four 700 kilowatts, three-phase.	Transmits power to Markgrafenstrasse.
Luisenstrasse . .	1899	2,000	6,000	——	Three triple-expansion vertical condensing, Sulzer 85 revs.	Direct.	Six 1,000 kilowatts, 250 volts, shunt-wound continuous current.	——
Oberspree		10,368	10.368	Chiefly Heine.	Two Horizontal Görlitz, 1,000 I.H.P. Two Vertical Görlitz, 2,000 I.H.P. Two Horizontal Görlitz, 4.000 I.H.P	Direct.	Four 364 kilowatts, three phase. Four 728 kilowatts, three-phase. Four 3000 kilowatts, three-phase	Transmits three-phase current at 6000 volts.
Moabit		9,000	9,000	Heine.	Three Horizontal, Sulzer 4,000 H.P.	Direct.	Three 3,000 kilowatts, three-phase. generators at 1000 volts.	

TABLE SHOWING THE EQUIPMENT OF BERLIN'S LARGE COMBINED LIGHT AND POWER STATIONS.



LUISENSTRASSE CENTRAL ELECTRIC STATION, BERLIN.

Four-cylinder vertical tandem triple-expansion Sulzer engines, 3,300 horse power. Installed by the Allgemeine Elektricitäts Gesellschaft.

Electricity Works is a separate company which controls the supply of electric power for all purposes in Berlin.

The tables on pages 526 and 528 embody data of some of the most interesting plants of the Berlin Electricity Works. These stations date back some fifteen years, and the last of the series is not yet quite completed. They supply Berlin with light and motive power, and also run the electric tramways, which are rapidly superseding horse and other methods of traction in that city.

The upper table on page 528 gives some idea of the rapid growth of the demand, and there seems to be no reason to doubt that this will steadily increase for the next few years in the same ratio.

The concession for the Berlin enterprise was given in 1884. The

GROWTH OF OUTPUT OF BERLIN ELECTRICITY WORKS.

Output in Kilowatt-hours.

—	Private Lighting.	Street Lighting.	Motors.	Traction.	Total.
	kw.-hrs.	kw.-hrs.	kw.-hrs.	kw.-hrs.	kw.-hrs.
1890	2,441,000	292,000	69,000	—	2,802,000
1891	3,455,000	294,000	274,000	—	4,023,000
1892	4,696,000	293,000	186,600	—	5,175,000
1893	5,179,000	291,000	238,000	—	5,708,000
1894	5,369,000	336,000	570,000	—	6,275,000
1895	5,907,000	359,000	1,071,000	—	7,337,000
1896	6,909,000	385,000	2,220,000	257,000	9,771,000
1897	8,094,000	408,000	4,009,000	1,758,000	14,269,000
1898	9,315,000	425,000	5,833,000	2,443,000	18,016,000
1899	10,143,000	485,000	7,759,000	10,167,000	28,554,000
1900	11,202,000	882,000	17,240,000	20,170,000	49,494,000

DATA OF SOME OF THE DIRECT-CONNECTED COMPOUND CONDENSING STEAM ENGINES IN THE BERLIN CENTRAL STATIONS.

——	Van Den Kerchove.			Görlitzer Maschinenbau Anstalt.	Sulzer Frères.	Sulzer Frères.
	Corliss Gear.	Ghent Gear.	Bonjour Gear.			
Rated power in indicated horse-power.....	800	1000	1500	1500	1500	3000*
Diam. of high-pres. cylinder in milli...	482½	736¼	800	930	875	high pres., 865
Diam. of low-pres. cylinder in milli...	863¼	1320	1450	1450	1300	inter. " 1250 1550
Stroke in milli.	762	1447	1100	1100	1200	1550 1300
Revolutions per min.	80-85	60–75	105-110	105-110	105-110	85
Diam. of outboard bearing in milli...	275	343	300	400	300	—
Length of outboard bearing in milli....	610	508	600	800	580	—
Diam. of inboard bearing in milli....	275	343	365	400	380	—
Length of inboard bearing in milli....	610	432	430&510	600	540&710	—
Length of shaft in milli	3950	10,900	10,150	13,000	11,000	—
Diam. of crankpin in milli	204	305	305	400	400	—
Length of crankpin in milli	248	292	290	370	350	—
Steam pres. in lbs. per sq. in. at throttle..	130	130	130	130	130	175
Steam cons'p'n in lbs. per indicated h.p. h.	17.6	15.9	13.5	13.8	13 8	11½

* Triple-compound condensers using superheated steam.

first power station was put into operation in 1886. At the present there are six power stations in operation or under construction, as follows:—

Schiffbauerdamm-Luisenstrasse	21,100	horse power.
Spandauerstrasse-Rathausstrasse	14,600	"
Mauerstrasse	14,500	"
Markgrafenstrasse	2,100	"
Oberspree	54,000	"
Moabit	36,000	"
Total	142,300	horse power.

The total engine power actually under operation amounts to 90,000 horse power.

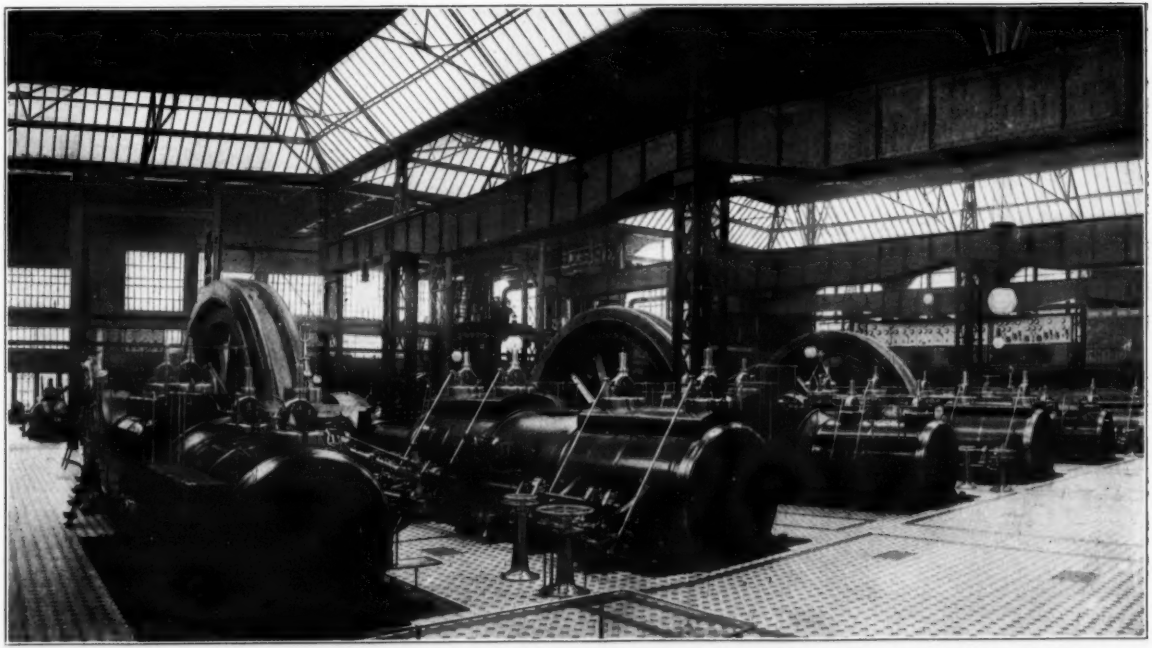
From 1885 to 1886 cross-compound vertical engines having a belt drive between the two cylinders were used. The valve gear was piston type. The cylinders were 360 and 580 millimetres diameter, stroke 360 millimetres, and 210 revolutions per minute. In 1888 to 1890 two-cylinder-tandem vertical Corliss engines were purchased from Van den Kerchove; cylinders were 482½ and 863½ millimetres in diameter with a stroke of 762 millimetres and running at 80 to 85 revolutions per minute, each direct-connected to one generator. In 1889 to 1893 cross-compound verticals of the same make were installed, the two cylinders being side-by-side with a generator at either end of the shaft. The cylinder diameters were 736½ and 1,320 millimetres, 1,447 millimetres stroke, and 60 to 75 revolutions per minute. A similar type by the same makers was installed in 1895 to 1897 with "Bonjour" valve gear, but otherwise similar to the previous type. Dimensions were 800 millimetres and 1,450 millimetres cylinder diameter, 1,100 millimetres stroke, 105 to 110 revolutions per minute. Sulzer Brothers of Winterthur in 1896-97, furnished similar vertical engines with Sulzer poppet valves, 875 and 1,300 millimetres cylinders and 1,200 millimetres stroke, 105 to 110 revolutions. The Görlitzer Maschinenfabrik also in 1896-97 put in the same type but with "Collmanns" valve gear. Cylinders were 930 and 1,450 millimetres, stroke 1,100 millimetres, and 105 to 110 revolutions per minute.

A larger and novel type of steeple-tandem triple-expansion engine was introduced in 1899. There is one high-pressure cylinder 865 millimetres, one intermediate 1,250 millimetres diameter, and two low-pressure cylinders each 1,550 millimetres. The stroke is 1,300 millimetres and the speed 83 revolutions per minute. The high-pressure

and intermediate cylinders are each above one low-pressure cylinder. The engine itself has four bearings, and there is an out-board bearing on each side of the machine to support the generators, of which there are two, one on each end of the shaft. The steam pressure at the stop valve is 12 kilogrammes per square centimetre at a temperature of 300 degrees centigrade. All cylinders, with exception of the high-pressure, are steam jacketted. As is usually the practice in Germany and Switzerland, only the back part of the frame carrying the slide on which the cross-head works is a casting, the front part of the engine being supported by polished steel columns. In all the engines mentioned above the condensers are worked directly by the main engine. This practice reduces the amount of power required by the condenser but has the disadvantage that should the engine be overloaded the condenser cannot be forced, and also should anything go wrong with the condenser the whole engine would probably have to be shut down. As is now generally the practice in all countries, the bearings are spherical and self-adjusting. The construction, finish, and general working of these engines is beautiful, but unfortunately the valve gear and the transmission of movement is of the most complicated nature. Any repair or examination of the low-pressure pistons is most difficult, and in some cases entails taking down most of the engine. Supervision, owing to the great height of these engines from the ground, is also arduous and expensive.

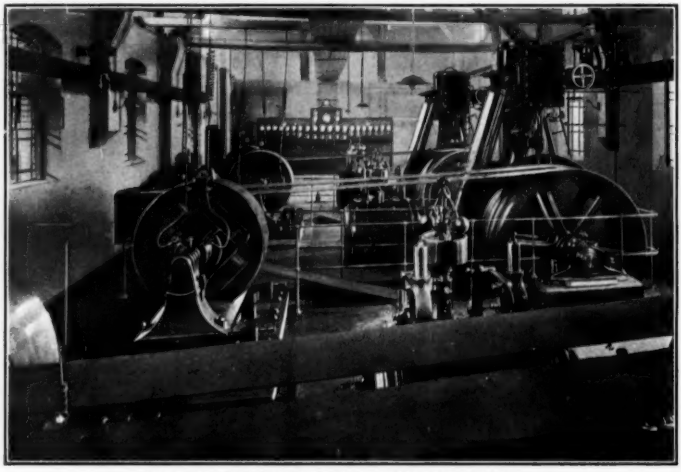
The remarkable result has been that, contrary to British or American practice, the engineers of the Allgemeine Elektricitäts-Gesellschaft, for all powers above 1,000 horse power, now install horizontal engines. The drawbacks of such large sizes are overcome by supporting nearly the total weight of the pistons and piston rods on a bearing between the two cylinders, in the case of tandem engines, or of building large bridgework projections at the back carrying a sort of auxiliary cross-head, which, with the main crosshead, carries the weight of the piston and piston rod.

In comparing the stations which have recently been installed in Berlin it will be found that American practice has been largely followed in their layout and construction. Berlin is more fortunate than London from the consumers' and suppliers' point of view, as it is there possible to concentrate the supply of electrical power for all purposes in the hands of one large company, who thereby are permitted to put up very large stations and to spend money freely so as to reduce the cost of production. If this had been possible in London similar results would no doubt have been obtained.



OBERSPREE STATION, BERLIN ELEKTRICITÄTS-WERKE. MACHINERY PUT IN BY THE ALLGEMEINE ELEKTRICITÄTS GESELLSCHAFT.

A careful study of the present situation should convince anyone that England is behind other nations, certainly from a manufacturing standpoint. The reverse ought to be the case.



ELECTRIC TRAMWAY POWER STATION, BERLIN.

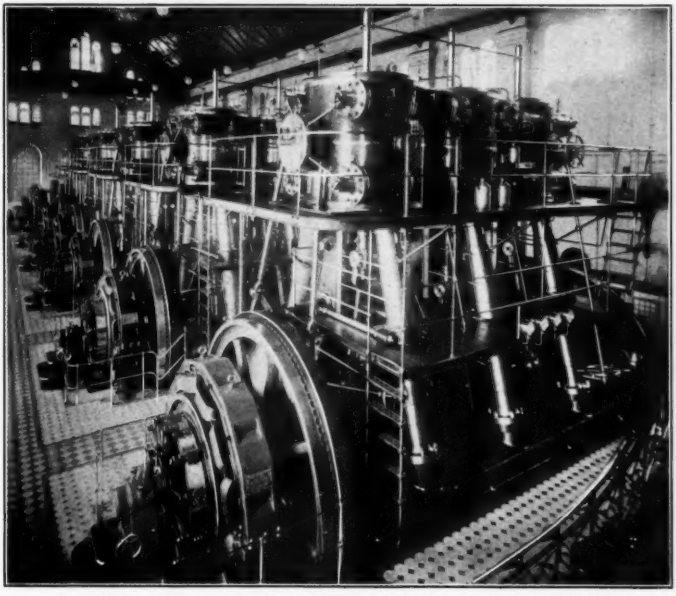
Showing combined vertical and horizontal engines, installed 1891, similar in type to the engines now being put in by the Manhattan Elevated Railway, New York.

There is little doubt that, notwithstanding the relatively poor show made at Paris, British steam engines are in their essential parts, and in working, at least equal to those of any foreign manufacturer. We should, however, not disdain the fine finish and the great attention to even the smallest detail which is the characteristic feature of foreign-built engines. All engineers know the good work turned out by the three great British engine builders who exhibited, but as far as outward appearances go they are distinctly at a disadvantage among their highly-finished foreign neighbours.

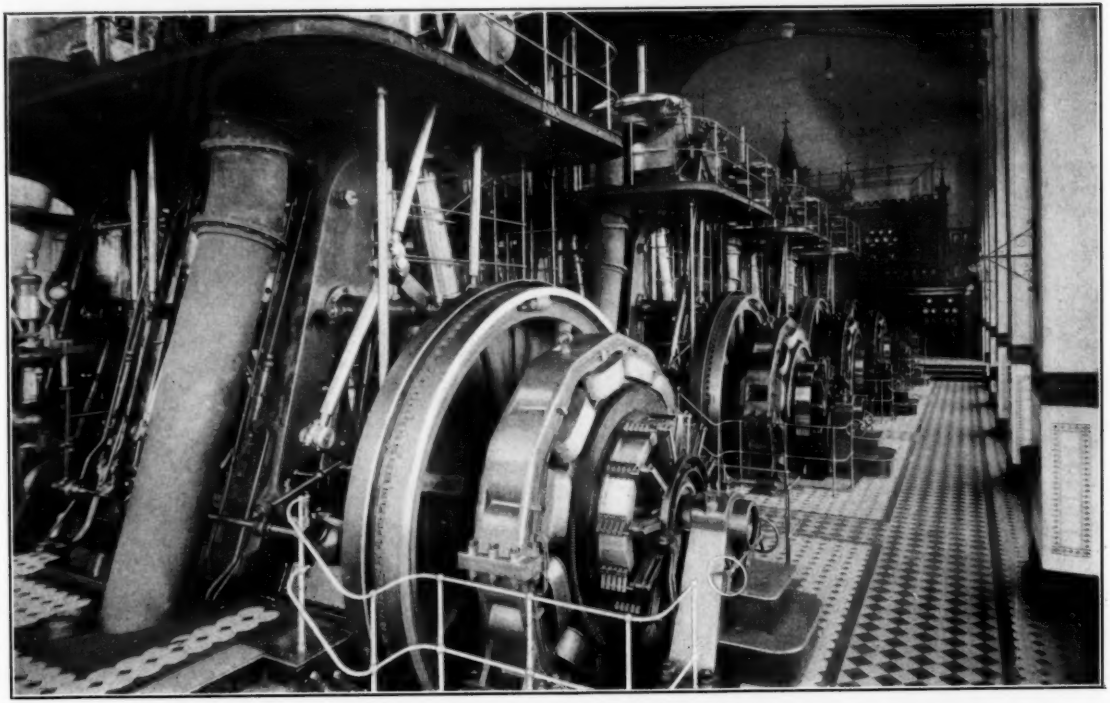
Unfortunately even this cannot be said as regards electrical machinery, as a glance at the foreign exhibits and the British soon proved. Some of the causes for this are very well set forth in a leading article in the *Times* of April the 19th, 1900, which served as an introduction to the excellent series of articles on "American Engineering Competition" that have appeared in its columns. The *Times* calls attention to our "countrymen's want of knowledge and the indifference of British manufacturers to the very real danger which menace their industrial position. Very few Englishmen go to the United States for observation and instruction as Americans constantly

visit Europe. It is difficult without personal enquiry to realise the competition that is preparing for us."

The electric power plant at Hamburg is a combined lighting and traction station, and has been considerably enlarged since it was originally laid down. The entire equipment was carried out by Messrs. Schuckert & Co. The electric-generating plant consists of seven direct-coupled steam dynamos. The engines are of the triple-expansion condensing vertical marine type; at 100 revolutions per minute and 147 pounds steam pressure, each engine develops 1,000 to 1,200 brake horse power. The height of the engine is about 24 feet 6 inches and it occupies a floor space of 26 feet 3 inches by 14 feet 9 inches, approximately. The high, intermediate, and low-pressure cylinders are placed side-by-side, the cranks being arranged 120 degrees apart. There are two flywheels to each engine, measuring about 13 feet in diameter and weighing 7½ tons each. Steam distribution is effected by Corliss valve gear, and the governor controls the cut off in both the high and intermediate-pressure cylinders. For lubrication an oil tank is placed on the top of each engine; after passing through the bearings, the oil is collected in another tank situated



A GENERAL VIEW OF THE HAMBURG POWER-HOUSE ENGINE ROOM.



ENGINE ROOM OF THE HAMBURG POWER HOUSE.

Eight 400-kilowatt vertical triple-expansion Khun engines, Schuckert dynamos.

BOILER HOUSE OF THE HAMBURG CENTRAL-STATION POWER PLANT.

underneath the bed plate, from which, after being filtered, it is pumped up to the upper tank. All the cylinders are steam-jacketted, the high and intermediate-pressure cylinders with boiler steam, and the low-pressure cylinder with steam from the intermediate receiver. The cylinders measure 22.64 inches, 36.41 inches, and 53.15 inches, by 39.37 inches stroke. Each engine is coupled direct to two dynamos, one on each end of the shaft.

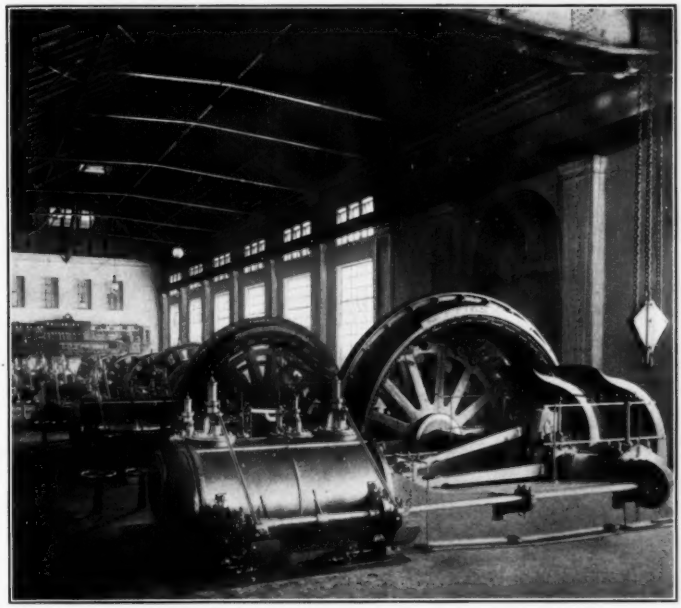
The boilers employed in this station are of the composite type so much used on the Continent, and consist, to all intents and purposes, of a marine-type "dry-back" superimposed upon a Galloway boiler. The upper boiler contains 125 fire tubes, each 3.74 inches in diameter; the lower boiler has a length of 19 feet 3 inches and a diameter of about 8 feet. Each boiler has a heating surface of 2,691 square feet. The furnaces are hand-fired.

It is not only Germany, France and Belgium which must be taken into consideration; Italy with the well known and successful firm of Franco Tosi of Legnano must not be overlooked. A short typical description of the engines built by this firm will, it is thought, prove of interest. The following gives a general idea of the standard practice of the Franco Tosi Co.

The cylinders are jacketted, the jacket being formed of a liner. The heads are also jacketted. There are four valves to each cylinder, the steam valves on top and the exhaust valves below. The piston is made in one piece, cast hollow and ribbed, giving strength without weight. The piston rings are made of cast iron.

The tandem and triple-expansions type of engines have box-girder frames with bored cross-head slides cast in one piece with the main crank-shaft bearing. The cross-compound engines are usually built as centre-crank engines, to admit of coupling on a generator each side. The frame consists of two symmetrical pieces, one right and the other left-hand, each frame containing a guide, one outer bearing, and half of the middle bearing. A flat one-sided guide is used.

The cranks and crank-shaft are of hammered steel with the cranks shrunk on. A high-speed Porter governor is employed. Poppet valves are mostly used, but in some a slide valve is used (generally either with single-cylinder or tandem-compound engines) with Rider cut-off controlled by Porter governor. In tandem engines the practice is to connect the low-pressure to the frame and place the high-pressure cylinder behind it. For triple-expansion, with three cylinders, the practice is to connect the high and medium-pressure engines tandem (medium-pressure in front) and the low-pressure cylinder parallel



FRANCO TOSI HORIZONTAL CROSS-COMPOUND ENGINES AND OERLIKON GENERATORS, GENOA CENTRAL STATION.

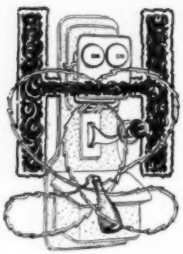
with them, the two cranks being at 90 degrees. With four-cylinder triple-expansion, it is usual to place one low-pressure cylinder tandem with the high-pressure cylinder, and the other tandem with the medium-pressure cylinder, the low-pressure cylinders being in front in each case, and the cranks at right angles. Franco Tosi also built a vertical high-speed type of engine, in sizes from 25 to 400 horse power. In these engines the steam distribution is effected by piston valves, with variable cut off controlled by a shaft governor.

With this necessarily brief review I must leave the subject of Continental steam-engine practice. My fourth and concluding paper will treat of the work done in this department of engineering in the United States.

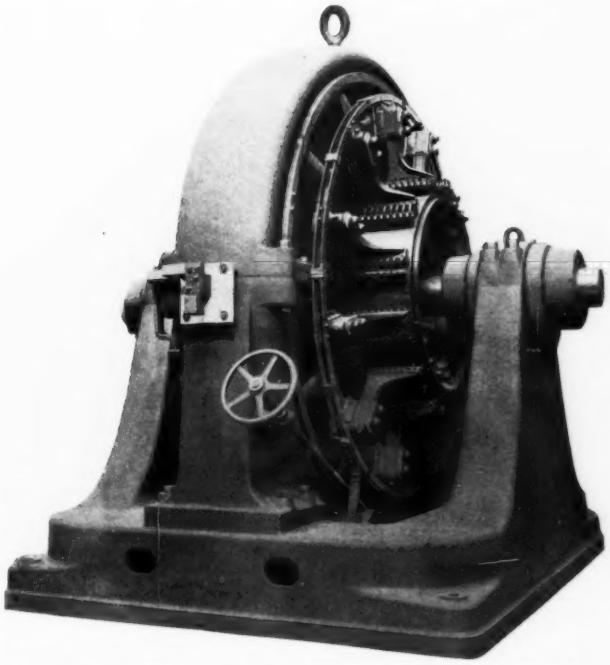
THE OPERATION OF THE ROTARY CONVERTER.

By David B. Rushmore.

Mr. Rushmore's preceding article, in our December issue, was concerned chiefly with the design and construction of the rotary converter. In the following pages he discusses its practical use and the phenomena of its operation.—THE EDITORS.



UNTING, as the phenomenon is usually designated, is an electrical and mechanical oscillation due to a variety of causes, which, in various degrees, is of frequent occurrence in the operation of alternating-current machinery. In practice it is often met in the parallel running of alternators or in the operation of synchronous motors. As regards its operating conditions, a converter may be regarded as a synchronous motor except that, as no mechanical power is taken off, the converter is the more susceptible of the two to the influence of slight irregularities in the conditions of electrical supply. One of the common causes of hunting is a variation in the angular velocity of the prime mover. This may be due primarily to faulty engine design, such as a short connecting rod, a governor which is too sensitive, or lack of sufficient flywheel capacity. The phase relations of current and electromotive force in the synchronous motor are extremely sensitive. If a sudden load comes on the motor, or if the frequency of the supplied current is slightly increased by the increasing angular velocity of the engine at that instant, the current of the motor increases and the position of the armature with respect to the field may become more favorable, so that there is a strong force brought into action to increase the speed of the motor. Now, as the revolving part of the motor possesses weight, it takes an appreciable time for this to occur; and the probability is that the strength of the synchronizing impulse has been more than sufficient to raise the revolving part to the frequency which

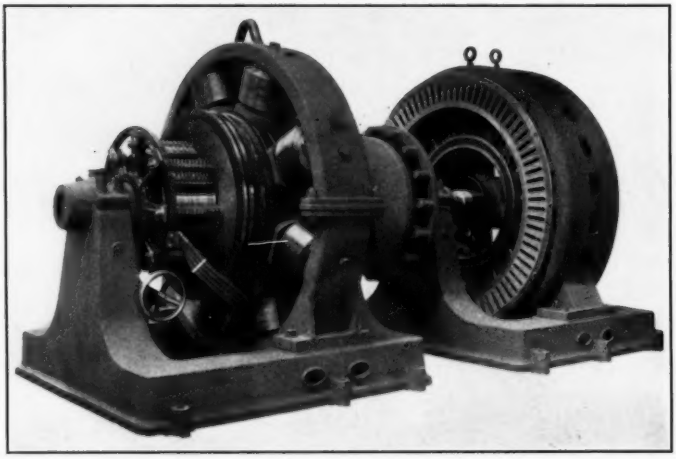


1,500 KILOWATT THREE-PHASE ROTARY CONVERTER FOR MANHATTAN ELEVATED RAILWAY, N. Y.

One of twenty-six built for the new power house by the Westinghouse Electric & Manufacturing Company, Pittsburg, Pa. They are the largest rotaries yet constructed.

existed at the time of the impulse, and the rotor will be sent ahead of synchronous position. If now, as the rotor increases in speed, the engine reaches a part of its cycle where the angular velocity is decreasing, and with it the frequency of current, the tendency will be to throw the motor ahead and out of step. The same result will accrue in the opposite direction at the other half of the engine cycle. In this manner the motor is sometimes ahead of and sometimes behind the proper phase position, and the instantaneous speed fluctuates above and below its proper synchronous value. The action is very much as if the transmission of energy between the alternator and the motor were accomplished mechanically by means of elastic cables. Then, as the angular velocity of the driving pulley varies, the cable would stretch but tend to change the velocity of the driven pulley at the same time. If the natural period of oscillation of the driven pulley be equal to or

a multiple of the period of change in angular variation in the driver, it is seen that a condition of mechanical resonance prevails, and that the amplitude of oscillation of driven pulley with respect to the driver will increase, and with it the force tending to rupture the cable. Owing to the inertia of the driven pulley, there will be a time lag in its response to the tension of the cable. If the cable (which corresponds to the

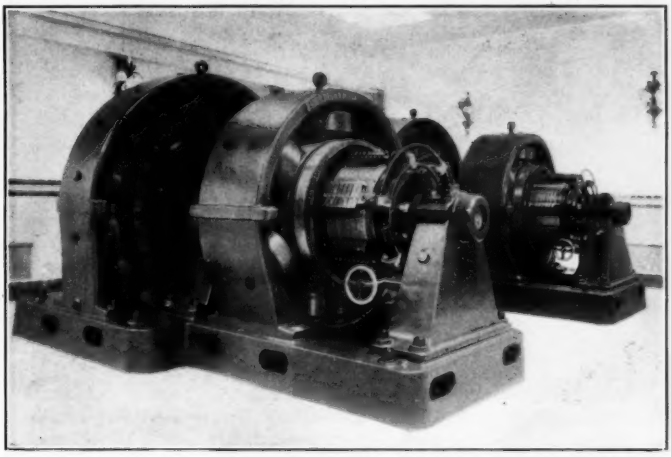


ROTARY CONVERTER, 3,500-VOLT POLYPHASE CURRENT TO 260-VOLT DIRECT CURRENT.
350 kilowatt, 375 revolutions and 50 periods; synchronous motor of 525 horse power. Built by the Maschinenfabrik Oerlikon, Oerlikon near Zürich.

synchronizing power of the motor) is of sufficient strength, there simply results a mechanical (or, with the motor, a combined mechanical and electrical) oscillation which may or may not be harmful. In a converter, the pitch of two poles is called 360 electrical degrees. If the mechanical oscillation around synchronous speed causes an electrical displacement beyond a certain point, the torque decreases and the motor falls out of step and comes to rest. If this point is not reached, the motor rotating-part simply oscillates backward and forward with respect to that of the alternator. If the ammeters in the circuit are undampened they show a kick of the needle at each revolution of the engine, and frequently a slight sound is given out by the iron of the motor. In this manner the speed of the driving engine is exactly indicated by the motor, even though they be at different ends of long lines.

With regard to the use of flywheels or of flywheel effects in converter armatures, there is some difference of opinion. Were the revolv-

ing part entirely without mass, the speed of the rotor would correspond exactly with the frequency at all times. If the natural period of oscillation of the converter armature bears a certain relation to that of the varying angular change in the generator such that resonant effects will result, the addition of a proper flywheel effect will change the natural period of oscillation and tend to smooth out the variation. In general, flywheel effect would seem to be helpful, viewed from this standpoint, when the variations are only those which occur regularly during a revolution of the engine. In order that alternators may run in parallel satisfactorily, it is best that the engines do not regulate too closely—that there be a perceptible, although small, drop in speed under load. When converters operate on railway systems, there is liable to be large and sudden variation in load, extending over some period of time. In this case the converter armature can follow that of the generator more closely as the flywheel effect is less. Where damping devices are used, the energy dissipated therein for a given displace-



750-HORSE-POWER SINGLE-PHASE MOTOR GENERATOR IN THE SUB-STATION OF THE FRANKFORT TRAMWAYS.

Built some years ago by Brown, Boveri & Co., of Baden, and interesting because the alternating-current motor is single-phase. The continuous-current dynamo gives current at 550 volts.

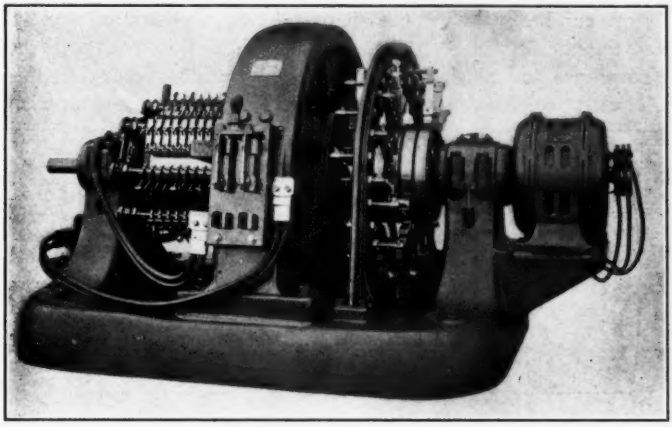
ment will be greater with flywheel effect than without. Whether the displacement would be sufficiently less with the added inertia to reduce the loss of energy as a whole, would depend upon the conditions in the individual cases. Variation in angular velocity, while an important source of hunting troubles, is only one of a number of causes which

TRANSFORMER ROOM IN THE MARIANNEN-STRASSE SUB-STATION OF THE BERLIN ELECTRICITY WORKS.

As the works have extended, additonal central stations within the city limits have been impracticable on account of the high cost of land and difficulties of fuel and water-supply. The system adopted therefore has been the erection of central stations outside of the city limits, generating polyphase current at 6,000 volts, which is transformed to direct current for lighting, power, and traction service at five city sub-stations. The one shown above has a capacity of 8,770 kilowatts, and was installed by the Allgemeine Elektricitäts Gesellschaft, Berlin.

may produce this result. The lack of armature reaction in a converter under best conditions of operation gives it a greater instability than a synchronous motor, while in the above the action of the two has been considered the same.

Any cause which varies the voltage impressed on the converter terminals will tend to produce hunting. This may come from too-high resistance or inductance in the line. The absence of armature reaction in a converter is due to a balance between two equal and opposite forces. The brushes being set at the neutral point, the effect of the continuous current is to distort the field in the direction of rotation, there being no demagnetizing effect. The reaction of the alternating current at unity power factor is equal to that of the continuous current in value and is opposite in direction. If either of these is altered or removed, the influence of the resultant is of course felt. At other than unity power factor there is a wattless component of the alternating current—that is, a component which represents a transfer, but not a utilization, of electrical energy; and this has a demagnetizing effect upon the field. If, with a sudden load coming on the converter, a drop in applied voltage due to line resistance or inductance takes place, the sluggishness of the magnetic circuit and the inertia of the armature prevent an instantaneous adaptation to the new conditions, and the counter electromotive force is too high. This causes a sudden pull on the armature to change the phase relations of current and electromotive force, and an impulse tending to cause the rotation to depart from synchronous speed is given to the armature.

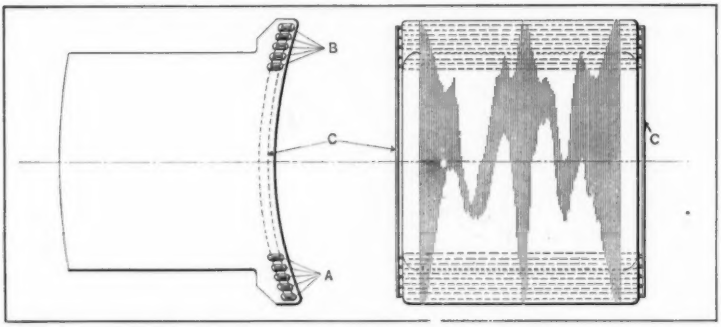


ROTARY CONVERTER FOR SIX-PHASE ALTERNATING CURRENT, DELIVERING DIRECT CURRENT AT 110 VOLTS.

Union Elektricitäts Gesellschaft, Berlin.

The magnetic result of a tendency to hunt is a shifting of the lines of force of the field across the pole face. At one instant the alternating-

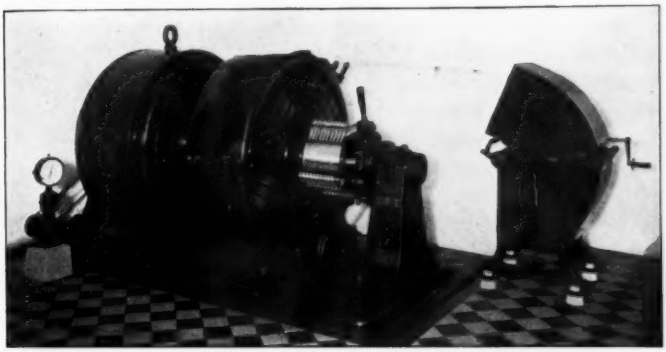
current reaction will be too great and the lines will be crowded to one pole corner. Then this will weaken, and the continuous-current reaction will crowd the lines to the other corner. This causes a shifting of the lines of force across the interpolar space and produces sparking. To prevent this, the armature teeth and the pole corners may be worked above the point of magnetic saturation, and copper rods or strips may be so placed at the pole corners that any incipient shifting of the field produces a powerful reaction. Below is shown a device for this purpose. A number of ducts are placed in each pole corner. Through these are run heavy copper conductors, A and B, which are short-circuited together at the ends by bars C, C. The ducts at the corners are so proportioned that the iron is highly saturated between them. With iron worked at this point, a considerable increase in magnetizing



ANTI-HUNTING POLE PIECE FOR ROTARY CONVERTER.

force but slightly increases the flux, and a considerable decrease in magnetizing force decreases the flux slightly. Therefore a variable armature reaction can cause but slight distortion of the field. What shifting of the field does result causes heavy currents in the conductors, which at once stop the change. With the conductors placed in this manner all of the currents induced are in a direction to produce useful result and no energy is unnecessarily wasted. They cause no decrease in the already small mechanical clearances of converters. The variations of magnetic flux at the pole face of very high frequency due to the slot openings cause no unnecessary loss, the circulation of air is not obstructed, and there is no danger that the device may work loose and strike the armature. Copper strips inserted under the pole corners are also used for the same purposes.

Where alternators are driven from turbines or from steam engines giving a nearly uniform angular velocity, and especially on systems

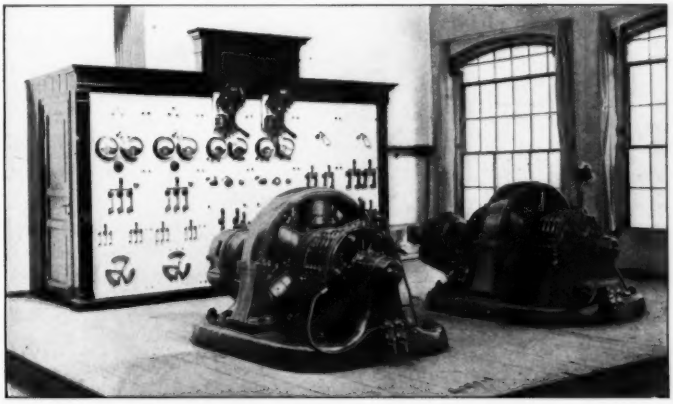


CONVERTER IN THE "PRINZREGENTEN-THEATRE" SUB-STATION, MUNICH.
Installed by the Allgemeine Elektricitäts Gesellschaft, Berlin. Takes polyphase current from the circuit of the city electrical works and furnishes direct current for the theater.

where converters are operated in conjunction with storage batteries, hunting is unknown. In most cases it has more of a theoretical than practical interest, and in but few cases is it a source of serious trouble.

Starting. Converters are not in general self-starting from rest, and some device is necessary to bring them up to speed, as with a synchronous motor. There are three usual methods of doing this.

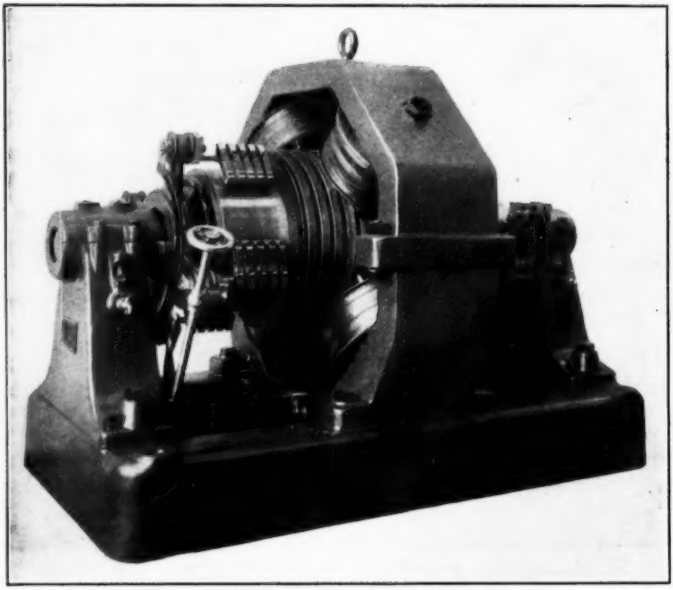
First, the converter may be thrown directly on the line through impedance coils or auto-transformers. An impedance coil is simply an



CONVERTER STATION; TWO ROTARIES OF 100 KILOWATTS EACH, DIRECT-COUPLED TO 5-HORSE-POWER INDUCTION MOTORS.
Installed by the Union Elektricitäts Gesellschaft, Berlin, for an accumulator factory drawing high-tension polyphase current from a distant central and converting it to low-tension direct current.

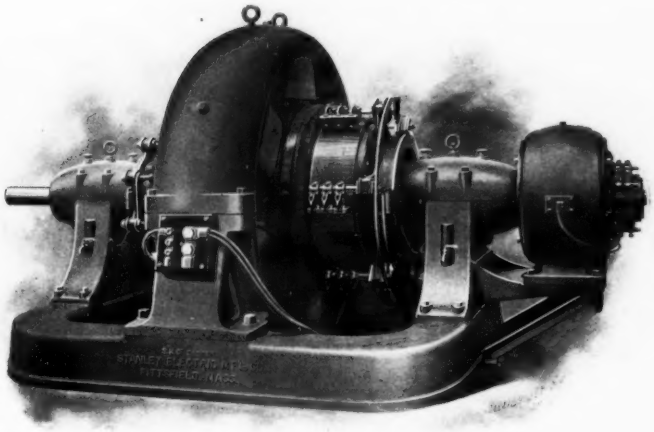
iron core on which is wound wire. This is placed between the line and the converter armature, and acts to choke down the voltage and prevents the great rush of current and consequent disturbance of the line which would occur were the normal voltage thrown directly upon an armature which was at rest. Often a number of taps are brought out from the winding, and the coil is cut out gradually as the armature comes up to speed, until it is entirely short-circuited, when synchronism is reached. This arrangement reacts upon the main line. As the starting current is usually greater than full-load running current, and at a low power factor, very little energy being consumed, the disturbance may be more or less undesirable, depending upon the conditions in each case.

With the auto-transformer we have one winding upon an iron core, as in the case above, but the terminals are connected across the line instead of in series with it. Taps are brought out at different points, and the voltage impressed on the converter may be made as low as desired. As the speed rises the voltage is raised, until full voltage at



100-KILOWATT ROTARY CONVERTER FOR AN EXTENSION OF THE MANCHESTER CORPORATION PLANT.

Transforming three-phase current at 260 volts and 30 cycles to direct current at 416 volts; runs at 900 revolutions per minute. Built by Brown, Boveri & Co., Baden.



350-KILOWATT ROTARY CONVERTER. STANLEY ELECTRIC MANUFACTURING COMPANY, PITTSFIELD, MASS.

synchronous speed is reached. The auto-transformer reduces the line current at starting in proportion as the applied voltage is lower than that on the line, and thus causes less disturbance than the impedance coil. As either of their coils is in use for but a very short time, they need not be large in order to fulfil their function.

A second method of starting converters is to mount, on the end of the shaft, a small induction motor, the synchronous speed of which is higher than that of the converter. The induction motor is then thrown across the transformer secondaries and brings the converter up to speed, after which it is cut out and runs idly under normal operation.

A third and most desirable method is, wherever possible, to start the converter from the continuous-current side as a shunt motor. There is no disturbance whatever to the line, the current drawn is small, and trouble with regard to obtaining the correct continuous-current polarity disappears. Where a number of converters are in a sub-station it is good practice to install a small self-starting converter or a small motor-generator set in order to obtain the continuous current.

When converters are started from the alternating-current side they act as hysteresis motors. The current in the armature induces a magnetic field in the pole pieces. As the iron has hysteresis, the induced field lags behind the current producing it and thus produces a torque.

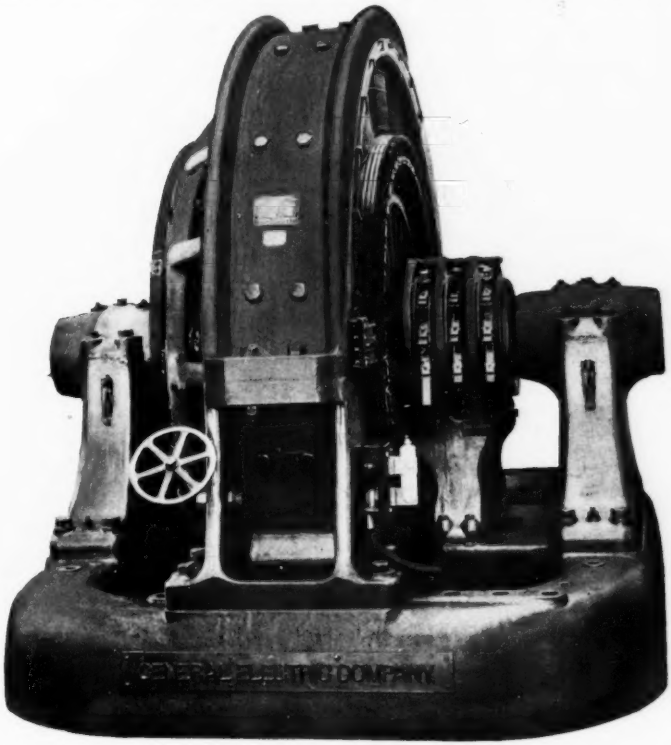
Converters with solid or laminated poles start with about the same apparent energy as measured by the volt-ampere input, but in the case of laminated poles the current is more in phase with the electromotive force. This is due to the fact that the magnetizing current necessary to produce the field is less by reason of the subdivided iron, which allows the induction to penetrate farther into the pole.

This transformer action in the field pole causes the generation of a considerable voltage in the shunt coils, which may rise to a dangerous height and injure the insulation if means are not taken to prevent it. The field circuit may be opened in several places and thus the addition of the voltage prevented. The field may be short-circuited upon itself, and a small but harmless current allowed to flow in the coils. This voltage may be considerably higher with laminated than with solid poles.

The "Inverted" Converter. The inverted converter is one used to transform continuous into alternating currents. Frequently it is desirable to extend the area which can be covered from a continuous-current power house. The distance may be considerable, but the amount of power small and insufficient to warrant the installation of an alternating-current generator. In this case, alternating-current transmission from an inverted converter in the power house is often wise. When, with further extensions of the system, alternating-current generators are used, the machine may be placed out on the line and used as a regular converter.

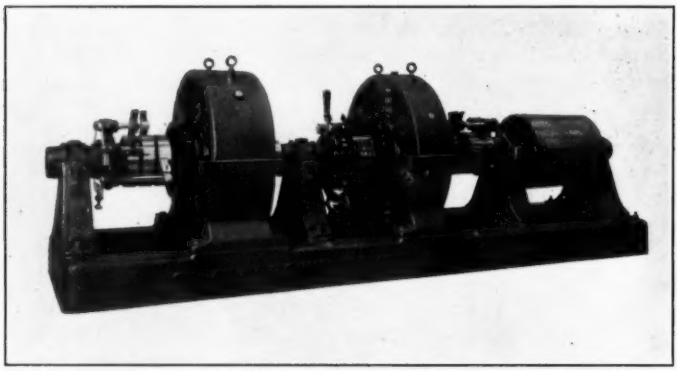
No radical difference exists in converters used for either purpose, and the principal point demanding attention when they run from continuous currents is that of speed control. With the alternating current there is a fixed synchronous speed which cannot be exceeded. On the other hand, there is nothing of the same nature to determine definitely the speed of a shunt motor, in which function the inverted converter operates. This, for a given machine, is determined by the field strength and by the impressed voltage. Under normal conditions of operation there is an absence of armature reaction in a converter, the air gap is small, the field comparatively weak, and a large number of conductors are wound on the armature. If the brushes are displaced from the neutral point, if the power factor (the ratio of actual to apparent energy) becomes low, or if, with a saturated magnetic circuit, the voltage is suddenly raised, the speed of the converter armature may increase beyond desirable limits. Two methods are used to prevent this danger and to keep the possible variation down to a few per cent. on each side of normal.

The first and better method is to excite the converter separately from a small exciter either mounted directly upon the shaft or else belted to it. The magnetic circuits both of the exciter and of the converter are worked below the bend of the saturation curve. The usual



1,000-KILOWATT CONVERTER, GENERAL ELECTRIC COMPANY, SCHENECTADY, N. Y.

cause of speed change would be a variation of an inductive alternating-current load. Suppose the converter to be running at the proper speed and this to happen. The inductive alternating current will react on the field and weaken it. In order that the counter electromotive force of the shunt motor may then equal the impressed, the motor with its weakened field must run at a higher speed. As soon as the speed begins to rise the electromotive force of the exciter rises much more rapidly, on account of its unsaturated circuit, and the field current is increased and with it the magnetic flux and counter electromotive force



AUXILIARY SET BUILT BY BROWN, BOVERI & CO. FOR DOLLFUS MIEG & CO. OF MULHAUSEN.

Serving as a connecting link between two alternating-current systems and as an exciter for a 1,200-horse-power three-phase generator. The set consists of:—(a), a synchronous alternating-current motor for three-phase 78 volts and 45 cycles; the motor runs at 900 revolutions, and the machine has a commutator so that it will give simultaneously 24 kilowatts for the excitation of a large generator and 63 horse power for driving the alternator; (b), the three-phase alternator for 60 kilowatts at 220 volts and 30 cycles. Driven by belt, instead of by the supply current, the set will give continuous current at 120 volts, three-phase at 75 volts 45 cycles, and three-phase at 220 volts and 30 cycles.

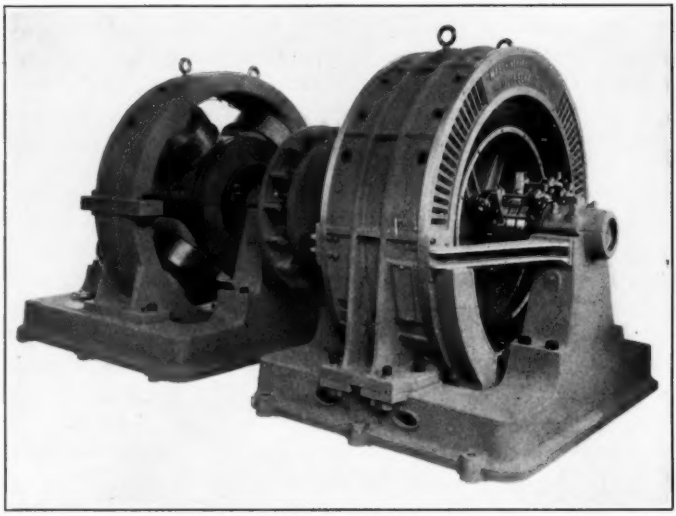
and the increase of speed ceases as soon as balance is obtained. If the load suddenly goes off the converter, the reaction disappears, the field is strengthened, and the tendency would be for the speed to fall. The instant this begins to occur the voltage of the exciter drops rapidly or dies away altogether. This weakens the converter field and makes a higher speed necessary for the generation of the proper counter electromotive force, which immediately checks the decrease of speed. In practice this method of control will keep the speed constant within a few per cent. on each side of the proper value. The counter electromotive force in a motor must equal the impressed voltage less a small drop due to resistance. Thus weakening the motor or converter field increases the speed, while strengthening it produces the opposite result.

The other method of speed control is to mount on the shaft of the inverted converter a small auxiliary converter, having the same number of poles but possessing no field winding. Series transformers are placed in the outgoing alternating-current lines and the current from them runs to the alternating-current rings on the small converter. The continuous-current brushes are in series with the field of the main converter. If the outgoing alternating current tends to weaken the

field, the reaction in the small converter increases the exciting current and thus strengthens it. Should the alternating current tend to strengthen the field, the auxiliary converter will weaken it.

Compounding. The compounding of a converter is a very different action from that which takes place in a continuous-current generator. In the latter, if we wish to increase the voltage under load, we wind series coils on the poles, which increase the field and voltage as the output rises. It is one of the strange properties of a converter that, if the applied alternating voltage be kept constant, we can not vary the continuous electromotive force by increasing or decreasing the field excitation. If the counter electromotive force of the motor is below that applied at the terminals, the character of the alternating current becomes somewhat changed and it reacts upon the field in such a manner as to increase it to a point where the proper counter electromotive force is generated. The component of the alternating current which does this does not represent an expenditure of energy, except as it increases the resistance loss in the conductors. It does, however, in practice produce a harmful effect upon the generator and line by causing a greater drop in voltage. If, on the other hand, the counter electromotive force of the converter is too high, a component of the alternating current flows in the armature, which decreases it. The reaction of this on the line is nearly always helpful in lessening the voltage drop and producing more satisfactory operating conditions.

The drop in voltage in transmission lines and electrical machinery is due to two causes. First, there is a resistance drop which represents an expenditure of energy which appears as heat in the conductor. Second, there is a drop due to the fact that a magnetic field is always formed around conductors carrying a current. The energy which appears in this magnetic field is not expended, but simply stored to be returned to the circuit when the current decreases. If we pass alternating current through a choke coil we get a drop in voltage due to this magnetic effect which is many times greater than the resistance drop. If we applied 1,000 volts continuous current to the proper coil of a static transformer a tremendous rush of current would follow which would quickly destroy it. Should the current be alternating, of the proper frequency, but a very small and harmless current will flow which will not even heat the conductors. The bearing of this upon the compounding of a converter is, that this can only be done when in the line leading to the machine there exists a certain amount of choking effect usually spoken of as inductance. Where the lines are short and the currents small, artificial choke coils are often placed in the line to

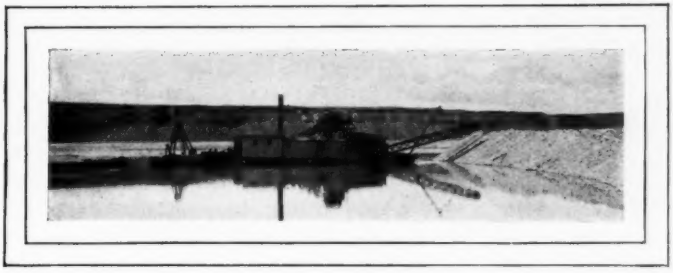


ROTARY CONVERTER, POLYPHASE CURRENT AT 6,000 VOLTS TO DIRECT CURRENT AT 450 VOLTS.

230 kilowatts, 370 revolutions and 50 periods; a synchronous motor of 350 horse power. Maschinenfabrik Oerlikon.

produce this effect. This occasions a considerable drop in voltage across the coils. Now the excitation of a converter may be so adjusted that, as the continuous-current load increases, the relation which this inductive drop bears to the line voltage will be such that they will add together and thus increase the alternating electromotive force impressed upon the converter terminals. The ratio of transformation in the converter being practically constant, the continuous-current voltage will be raised. The amount of this increase may be sufficient to compensate for the drop in pressure due to other causes, or it may be sufficient to increase the voltage as the load comes on, and overcompound or act as a booster. Varying the field excitation without at the same time varying the applied electromotive force, has practically no effect upon the continuous-current voltage and serves only to increase the alternating current.

Another method of varying the continuous-current voltage is to use regulators on the transformer coils. The possible range of voltage at which converters may be worked requires that in nearly all cases transformers be used to step down the pressure before it be led to the collector rings. The voltage on these may be varied by bringing out a number of leads, to be cut in or out as a change in voltage is desired.



THE RUSSIAN LAW OF GOLD MINING.

By C. W. Purington and J. B. Landfield, Jr.

The article below supplements the preceding study of gold-dredging possibilities in Russia, by the same collaborators, and the earlier paper by Mr. Purington on lode mining for gold in Siberia, both lately published in THE ENGINEERING MAGAZINE. They gave an idea of physical conditions; this summarises the statutory conditions under which mining enterprise —so far at least as the precious metals are concerned—may be prosecuted in the Russian Empire. To this section Mr. Landfield's thorough knowledge of Russia and the Russian language has been particularly valuable.—THE EDITORS.

THE mining law in force in the Russian Empire has as its fundamental principle the tenet that mineral wealth is movable property, and bears no relation to the estate on which it is found. The right of the operator to hold the ground ceases when he shall have exhausted the mineral resources therein contained. In other words, the tenure by which claims are held, as will be seen by reference to the following articles of the mining code, is practically perpetual lease from the government—that is, absolute title guaranteed so long as the small annual taxes are paid. The provision that the tenure is good until the mineral is exhausted is explained by the fact that until recently almost all the gold-mining of Russia and Siberia was placer mining, and that when the gravel had once been worked over it was intended that the operator should not stand in the way of further development.

The following outline of the law as it relates to gold mining is taken from the "Digest of Mining Statutes and Monetary Law," fifth

edition A. F. Skorof, Moscow, 1900. (In the Russian language.) The translation as given is only sufficiently full for the purposes of clearness.

Sec. 263, 264, 265, 266, 267:—The pursuit of the mining industry, including the locating and the patenting of claims, on free government lands, is allowed to persons of all conditions possessing rights of citizenship, Russian subjects or foreigners, with the following exceptions: Members of the secular clergy; officials connected with the mining bureau of the Department of Agriculture and Domains, and members of their families; certain classes of Jews, in those portions of the empire where the law forbids them to reside; criminals whose civil rights have been forfeited; and, in districts in which they serve, all police officials whose duties are judicial or have to do with the mines.

In the Maritime Province (which includes all the Pacific coast of Siberia), none but Russian subjects are allowed to pursue mining. This regulation, (432, note) was decided on as far back as 1885. Special permits for foreigners to pursue mining in the Maritime Province have been given in rare instances.

Sec. 427:—Gold deposits situated on the free government lands, or on those belonging to the cabinet of His Majesty the Emperor, are placed at the disposition of private operators, the land being held not as property, but in temporary holding, up to the exhausting of the mineral resources.

Sec. 417, 418:—The exploitation of gold placers and veins is allowed, according to the regulations set forth in Secs. 416-540 of the Code, with certain exceptions in the Ural, Altai, and Nerchinsk districts, and in the Maritime Province.

Sec. 428:—The possessor of a tract of gold-bearing gravel enjoys, as long as he possesses it, the right to the lodes which are found within the concession, without demanding a special authorization to this effect, and without paying on this account a supplementary tax. But the making of a declaration to the local agent of industrial surveillance is required. In the same manner, the holder of a tract given for the exploitation of a lode has the right to exploit gravel situated on his ground.

Sec. 430:—The right of the gold miner to the deposit exploited by him is considered as that to movable property, chattels, (*imushtchestvom dvizhimim*), according to Art. 403 of the Civil Code.

Sec. 437:—The persons authorized to exploit gold veins and placers have the right, conformably to the principle of common law,

to form, and to become members of, companies for that purpose. Copies of the by-laws of the company must be presented to the local mining office and to the Department of Mines.

Sec. 440:—To undertake the prospecting for auriferous gravel-deposits and gold-bearing lodes, each person, or each company, must provide himself or itself with a prospecting permit.

(Such permits, good for the whole of eastern Russia and Siberia, with the exceptions above-mentioned, are easily obtained from the mining offices in Ekaterinburg, Tomsk, and Irkutsk. They are given on proper application, accompanied by the passport of the applicant. The cost is nominal, from $2 to $3. The permits are good for life.)

Sec. 444:—The prospector (provided with his permit) must give notice to the local mining office, before setting out, specifying the members of his party, what papers they possess, and the time and starting-point of the expedition. In the districts of eastern Russia the local police must also be notified.

Sec. 448:—The ground located is indicated, if a gravel deposit, by two stakes marking the extreme points and inscribed "occupied such a day, such a month, such a year, by such person or company for prospecting purposes." If it be a lode claim it is marked by a single stake, with the same inscription repeated on its four faces.

Sec. 451:—If, after testing, the ground is considered worth declaring as a mining location, it is required that two pits be dug, and one prominently marked stake be left to hold the location.

Sec. 453, 460:—An exact description of the ground located must then be prepared in four copies, one of which is sent at once to the district police, the others to the local mining office, the district mining engineer, and the local land office.

Sec. 463:—All re-locations of a mine already located are counted void, even if the law has not been complied with for obtaining patent; (i. e., a would-be claim-jumper has no status in court even if the original locator has not complied with the law.)

Sec. 467, 468:—As soon as possible, but at longest within two years, a government survey and platting of the claim is ordered by the district engineer. This corresponds to a land-office patent in the United States. (In practice a petition is made by the locator to the district mining office, if he cares to have the survey made at his own expense. In this way it is done much more expeditiously, and the expense is very slight.)

Sec. 475:—The area of claims is as follows:—1, in east and west Siberia, the entire length of one placer claim must not exceed five

versts (17,500 feet) up-stream from the location stake; in width it may take in the breadth of the valley, to a limit of 1,750 feet on either side of the main stream. 2, in the Ural and other portions of European Russia, the length of the claim must not exceed 17,500 feet, and it must measure not less than 700 feet in width, in such a manner that the entire area of the claim does not exceed 250,000 square sazhenes (280 acres, very nearly). 3, a gold-quartz claim may have any dimensions, so long as it does not exceed one square verst, or 280 acres, in area, and providing its width measures at least one-third its length.

Sec. 533:—Land held for gold-mining purposes is subject to an annual tax after patenting. In the Olekma district of east Siberia this tax amounts to $1.80 per acre annually. In the Amoor district, to $0.60 per acre annually, and in the rest of Siberia, and the Ural, to $0.18 per acre annually.

Sec. 782:—The auriferous lands are divided into three categories:—1, the Olekma district; 2, the Amoor district; and 3, the remainder of the Siberian districts, the Perm and Orenburg governments of the Ural, and the Kirghese steppes. The tax on the gross output of gold is fixed at 10 per cent. for mines lying in the first category, 5 per cent. for those in the second, and 3 per cent. for those in the third.

Sec. 782:—All the placer gold and bullion obtained in the course of the operations must be recorded by the mine management in gold-books, margined and paragraphed.

Sec. 783:—These books are prepared by the operators, who must present them at the latest by the first of January, each year, to the local mining office, to have them countersigned and sealed, after which the said books are given back to the operators not later than the first of March, each year.

Sec. 787:—The gold extracted by the operators must be delivered by them, under their seal and with the certificate of the district engineer or his representative, to the government assay office, either at Ekaterinburg, Tomsk, or Irkutsk, according to the district in which the mine is located.

Sec. 788:—As it comes in it is weighed, run in bars, and assayed on four faces in presence of the operator.

Sec. 789:—After the weighing and assaying of the bullion a detailed return is made out, specifying the quantity of the pure metals and the price to be paid according to the rate of conversion, with deductions for tax, transport, coinage charges, etc.

Sec. 791:—As guarantees of the amount due them, the mining

department issues to the operators orders on the St. Petersburg Mint, for any sum exceeding 150 roubles, good for six months.

Note 3; These orders are immediately negotiable at local banks or private hands.

It is, of course, not to be denied that certain features in the system of administration above outlined are trying to the operator, especially to one accustomed to western modes of thinking and procedure. Siberians, even when carrying on operations of considerable magnitude, and in localities widely separated from one another, appear to have no difficulty in complying with all the numerous regulations in regard to gold-mining. The employment of numerous clerks, men who are entirely familiar with the mining law and its requirements, facilitates matters to a large extent. Scribes of all kinds, as well as mining surveyors and draughtsmen, command very small pay in Russia and Siberia, and the quality of the work done by them is excellent.

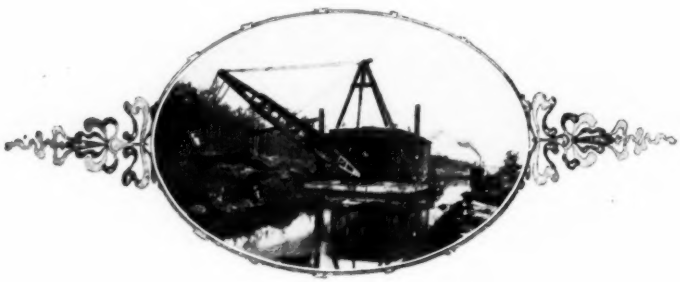
The expenses of locating and patenting claims in the Ural and in Siberia is very little. The size of the claim being optional with the locator, up to 280 acres, he rarely finds it of advantage to include more than 200 acres within his lines. The average cost of locating and patenting such a claim, including all field and camp expenses, will not exceed $125. Particularly noteworthy throughout the mining code is the effort to give perfect title and to prevent litigation. All locations must be patented within two years and no title or assessment work is required. All of the court decisions under the mining code show the precedent that failure to comply with the unimportant and purely formal technicalities of the law does not interfere with a man's title. To those who have mined in other parts of the world, perhaps the most striking feature is the large amount of land that can be located in a single claim. This liberality has, as a matter of fact, been the chief obstacle to the progress of Russian mining, as it has enabled unprogressive men to hold large tracts of valuable mineral land without being obliged to do assessment work thereon, but simply sit still and wait for a purchaser.

The complete statistics of the industry obtained by the Government, through its inspection and purchase of all the gold, are really of great advantage to prospective purchasers of Russian or Siberian mines, though their accuracy is sometimes affected by the clandestine purchase of gold by local operators, turned in as their own product. The features of the code providing for careful government supervision resulted from the exigencies of the convict system, and the requirement that all gold be sold to the Government. Now that the

sending of convicts to Siberia has been done away with, this supervision is much less important; nevertheless, the code provides carefully for various governmental inspections, which have as their object the protection of the health, safety, and welfare of the laborers, and the prevention of the clandestine traffic in gold. There is the amount of red tape that might naturally be expected of a code enacted by central officials in a bureaucratic government, but in practice most of these provisions are dead letters. The mine operator who is not impatient or overbearing and who will exercise a reasonable amount of tact and courtesy, as well as deference to ingrained local prejudices, will have no difficulty.

Personal experience in the locating and patenting of mining claims, and in actual operations on the ground under the Russian law, has convinced the writers that the numerous rules which must be observed are not nearly so great a hindrance to production as might at first appear. If, on the one hand, the gold miner is closely watched by the government mining department and its branches, he also receives a protection of his territory and mining rights which renders him secure from the dangers of litigation. The administrators of the mining department, especially those high in authority, the writers have found to be men of progressive ability, disposed to render every courtesy to the law-abiding foreigner.

That it is the desire of those in authority to see an increase in the gold production of the Empire can hardly be doubted in view of the fact that each year fresh concessions are made in favor of the miner. Notable among these was that of 1898, by the provisions of which all foreign machinery intended for gold-mining purposes, entering Russian territory at whatever point, within ten years after the passage of the law, pays no duty.



PRACTICAL APPLICATIONS OF REINFORCED CONCRETE.

By Jacques Boyer.

In view of the widely extending use of combinations of concrete and metal, and the importance of the intelligent and scientific applications of the method as opposed to empirical and arbitrary designs, the following exposition by Professor Jacques Boyer of the development and progress of reinforced concrete will be found both valuable and interesting. The most extended applications of this form of construction have been made in France, and it is by French engineers that the most thorough and scientific study has been given to it; and while other parts of the world have not been neglected, it is from France that the greater portion of the experience and illustrations for Professor Boyer's papers has been drawn.—THE EDITORS.

THE discovery of cement is credited to two Englishmen, Parker and Wyatt, who obtained this product for the first time by the calcination of argillaceous nodules (1795), and since that date it has found innumerable applications in every department of civil engineering. Among these applications of later date came the invention, by Léon Coignet, of *béton* or concrete, of which he made artificial blocks as hard as natural stone. It has been impossible to discover to whom the engineering profession is indebted for the idea of imbedding a metallic skeleton structure within a mass of hydraulic mortar or concrete, but a boat constructed in this manner was shown at the Paris exposition of 1855; about the same time Coignet built some dams of iron and concrete, and five years later he applied the method to the construction of floors. These early combinations, however, did not show a satisfactory resistance to tension, and the system was considered too dangerous for use in building construction. It has been only within the past ten years that practical engineers have undertaken to reinforce the portions of a structure under tension by members of iron imbedded in concrete, deducing the rational methods of construction now known and included in the general term of reinforced concrete *(ciment armé)*. Very recently, in consequence of the successful experience of MM. Cottancin, Hennebique, and Monier, in France; of Melan, in Austria and Germany; and of Hyatt, Jackson, and Ransom, in England and America, this method of construction has been welcomed and accepted very generally. A study of the

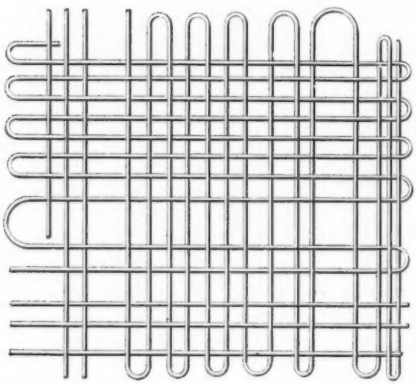


FIG. 1. LATTICE-PATTERN REINFORCING SKELETON, COTTANCIN SYSTEM.

various systems and methods should therefore form a subject of interest to every engineer who desires to keep abreast with the progress of the profession.

Skeleton structures of the principal systems:—At the present time the term reinforced concrete is understood to refer to a structure composed of a metallic skeleton imbedded in a mortar of cement concrete. This definition being accepted, we may pass successively upon the methods adopted by the principal constructors.

The first applications of the Cottancin system go back to the year 1889. This system consists in the preparation of a network of iron wire of varying mesh, corresponding to the varying loads which are placed upon the different portions of the concrete structure. The methods of arranging the network adopted by M. Cottancin differ according to circumstances. (Figures 1 and 2.) The arrangements most frequently adopted are those in which the reinforcing wire is woven back and forth between through wires, so as to bind the various parts of the system thoroughly together, the weaving being closest at the points of heaviest loading, as has already been noted above. Since the employment of a very close mesh is apt to prevent the concrete from filling the interstices completely, it is found advisable instead to use at the points of heaviest loading rods of heavier section than those of 4.5 millimetres diameter ordinarily employed.

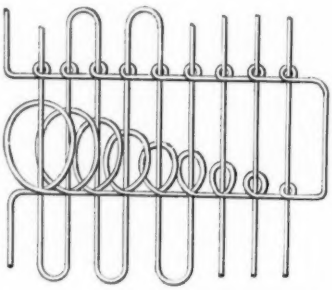


FIG. 2. CONTINUOUS SKELETON WITH WOVEN SPIRAL, COTTANCIN SYSTEM.

The metallic skeleton of the Monier system is less complicated, being formed of two lines of horizontal rods, intersecting each other at right angles. (Figure

3.) The lower rods *a*, called the resistance members, are spaced 10 centimetres apart, and are made of a section varying with the load to be supported. The upper, or partition rods, are bound to the lower ones by wire ligatures of 1 millimetre in diameter at the points of intersection. When the load is very heavy several combinations of this kind are used together.

The Hennebique system is based upon the following principle, viz., the provision, in a beam of concrete, of the necessary resistance to tension, which it otherwise lacks; this being accomplished by the means of tension members of iron suitably placed. The upper, or compression, portion of the beam of concrete is connected to the iron rods of the lower, or tension, portion by means of stirrups of flat iron, the structure thus corresponding, so far as distribution of stresses is concerned, to a standard I beam; the whole being imbedded within the mass of concrete. (Figures 14 and 15.)

The Bonna system of reinforced-concrete construction differs materially from other methods. This engineer aims not only to produce a monolithic structure of concrete, but also to provide it with a complete metallic skeleton. In fact the skeleton of an edifice constructed according to this system is distinguished from that of an ordinary building only by the lightness of the framework, the small number of bolts, and the total absence of braces and reinforcing plates. The principal purpose of the employment of bolts and connecting members is to sustain the framework, and maintain it in position until the concrete has set and become hard. This construction enables the computations for resistance to be applied in a very advantageous manner, and with great economy of material. In practice, rolled sections are preferred to round rods, because of the rigidity which they possess apart from the support of the concrete. In fact, when round rods are employed it is necessary to provide for the dislocation which would take place under the weight of the concrete itself before it becomes hard and is united to the metal. Unless such precautions are taken the reinforcing members of iron rod or wire may be so changed in position as to affect materially the strength of the combination. It is much easier to erect a structure of rolled sections than one of round rods, and since the framework is self-sustaining it may be completed before the concrete is applied.

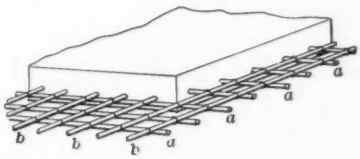


FIG. 3. REINFORCEMENT ON MONIER SYSTEM.

The sections usually employed in the Bonna system are in the form of a cross, of rolled steel, examples being given in the illustrations, Figure 4. These range from 110 grammes to 1.75 kilogramme in weight per running metre, the moment of inertia being much greater than for round bars of the same sectional area. These forms also permit the use of junction plates, by means of which the structure may be assembled and united into a continuous whole, and the extended surface permits a better contact and adhesion of the concrete. This

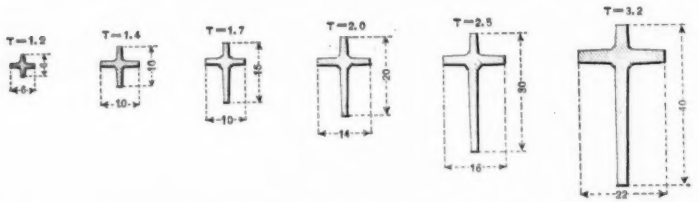


FIG 4. PRINCIPAL STEEL CROSS-SECTIONS EMPLOYED IN THE BONNA SYSTEM. All measures are in millimetres. T = thickness.

system has been extensively employed in France for floors and for arched coverings. In practice the edges of the flanges are marked with slight nicks at regular intervals, each bar thus forming a measuring rod, enabling the structure to be erected rapidly and accurately, the position of each piece being readily indicated. For any light structure, such as a tank, for example, it is a simple matter to mark off the members in the shop, and send them to be erected at a distance. Upon arrival the erection can be accomplished by the insertion of a few bolts, the work being performed by ordinary labourers under the direction of a skilled foreman.

When heavy loads are to be supported, M. Bonna uses sections of 30 by 30 millimetres and of 40 by 40 millimetres, of various thicknesses. The usual arrangement is to make tubular beams of four angle-irons, joined by flat plates, or to construct beams of sinusoidal form, using the cross-shaped sections. These beams are placed so as to sustain the principal loads, even before the imbedding concrete is added. The maximum bending moment and the maximum shearing efforts are transmitted to the extremities of these beams in such a manner that the shearing efforts are resisted by the accessory reinforcements.

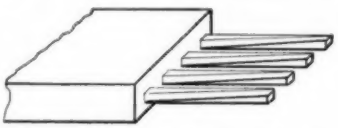


FIG. 5. REINFORCEMENT, RANSOM SYSTEM.

FIG. 6. SPINE-REINFORCEMENT FOR THE FLOORS OF A BUILDING, COTTANCIN SYSTEM.

The Bordenave system closely resembles that of Monier. The distinguishing feature is that the reinforcing rods are neither round nor square in section, but are of the I, U, or L shape.

In Austria the Melan system is much used, especially for the construction of arches and floors. In this system the arch is composed of I beams imbedded in the concrete, the profile being determined by the centering and abutting against the floor joists when used for floor construction. This arrangement presents much similarity to the Ransom system, except that in the latter the reinforcement consists of stout rods of square section, twisted so as to prevent any possible slipping in the mass of concrete. (Figure 5.) At first sight this method seems inferior to those in which the metal and the concrete are freer to play their respective parts in resisting the stresses. There appears also a disadvantage in the absence of connecting members between the rods.

The Hyatt system uses the metallic reinforcement in the form of flat plates, placed vertically and pierced with openings through which round connecting rods are passed.

The system of the Expanded Metal Company is peculiar mainly in that it employs the well-known expanded metal as the material for the reinforcement of the concrete. This material, which is made by slitting sheet metal and drawing it out, possesses the advantage of being entirely in one piece for great lengths, and not composed of many separate wires as an ordinary wire netting must be. It is applicable not only to floors, ceilings, and similar work, but to arches, and general engineering construction.

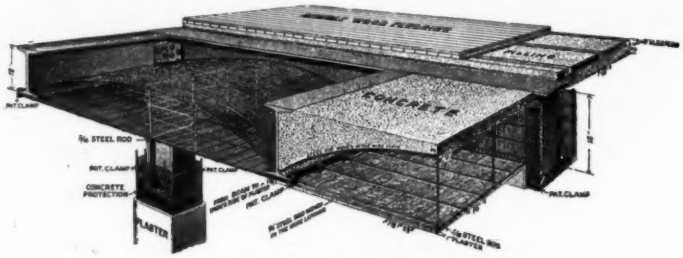


FIG. 7. THE ROEBLING FIREPROOFING SYSTEM.

The Roebling system of fireproofing construction, which is extensively used in the United States, is mainly employed for floors of steel-skeleton buildings. The fundamental principle consists in the use of arches of round rods and of wire network, these arches being sprung from beam to beam and resting on top of the bottom flanges of the beams. The rise of the arches is somewhat less than the depth of the floor beams, so that when the whole space, including the spandrels, is filled with concrete up to the level of the top flanges, the reinforcing arches are entirely imbedded in the concrete. The arches of rods and wire netting are strong enough to bear considerable weight without the concrete, and when the whole is completed it makes a solid and satisfactory construction. The details are well shown in the illustration.

Having thus mentioned the principal systems we may proceed to examine different examples of construction in each of them.

Floors and Ceilings.—M. Cottancin employs a system of beams which he calls "spine-reinforcement" *(épines-contreforts)*. (Figure 6.) This system employs beams of concrete formed about a metallic skeleton and placed on edge to obtain the maximum resistance to bending. The wires of these beams are interwoven and secured to

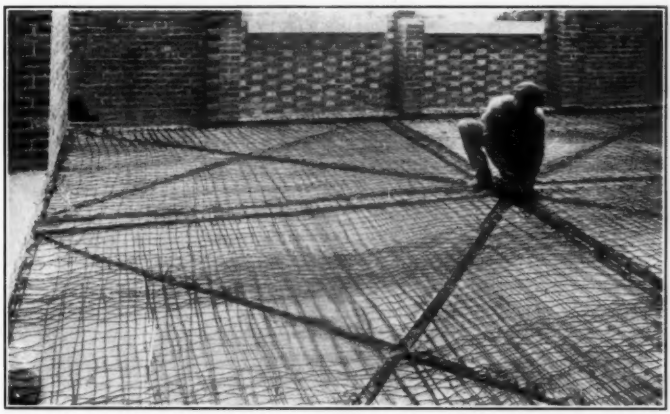


FIG. 8. TYING THE HORIZONTAL NETWORK TO THE SPINE-REINFORCEMENT, COTTANCIN SYSTEM.

those of the horizontal network both above and below, in order to secure the greatest rigidity. (Figure 8.) Theoretically this arrangement may be considered as a sort of lattice, as A B C D, Figure 10, with its upper and lower chords connected by flat diagonals crossing without interruption. The verticals, *A* and *B*, acting in compression, are replaced by the mass of concrete, while the verticals *A'* and *B'*, acting in tension, are replaced by the wires of the skeleton. Tests

FIG. 9. ROEBLING SYSTEM OF FIREPROOFING. VIEW TAKEN UNDER CANADIAN PACIFIC TRAIN SHED, MONTREAL.

made in the laboratory of the Ponts et Chaussées de France have demonstrated that floors of this construction are of ample strength when the spaces do not exceed 1.30 metres, if wires 4 millimetres thick are used and the total thickness of the mass is 4 centimetres. The intersections of the beams are arranged so that the surfaces are smooth and flat, care being taken in all cases to place the supports according to the disposition of the loads. It is altogether possible at the same time to place the points of support to meet the artistic requirements of the architect. M. A. de Baudot, who has made extensive use of the Cottancin system, has found it especially adapted to meet the artistic and structural requirements of modern ornamental architecture.

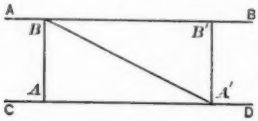


FIG. 10. DIAGRAM OF A LATTICE GIRDER, COTTANCIN SYSTEM.

As regards the ceilings, the crossed arrangement of the beams permits the employment of very artistic effects. The method employed by M. Cottancin is to provide the beams with lower flanges, C and D, Figure 11. These are intended to support the light slabs of reinforced concrete which form the ceiling. During the construction these slabs are held up against the under side of the floor by small props, in the position A, B, and when the concrete has set they are permitted to drop to the position C, D. This operation is clearly shown in the photographs, Figures 12, 13, and indicates the manner in which the use of expensive scaffolding is avoided.

The characteristic feature of the Hennebique system lies in the construction of the beams. These are rectangular prisms of cement-concrete with rods of iron or steel imbedded in the lower portion, these latter being tied in to the rest of the beam by stirrups of iron. A later improvement consists in the addition of a second set of rods placed parallel to and beneath the first set, in the same vertical plane. This second set of rods performs a double function. First, they form, in connection with the first set and the stirrups, rigid triangles of which the shearing resistance increases as the point of support is reached, where this effort is a maximum; second, these reinforcing members follow exactly the path of the bending effort of a continuous girder of several spans, permitting the application of the corresponding methods of computation.

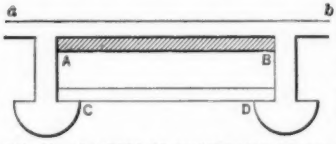


FIG. 11. FLANGES OF SUPPORTING BEAMS, COTTANCIN SYSTEM.

Thus it will be seen that M. Hennebique has succeeded in con-

FIG. 12. SLABS OF REINFORCED CEMENT SUPPORTED ON THE FLANGES OF THE SPINE-REINFORCEMENT TO FORM A SCAFFOLDING.

structing a homogeneous beam composed of heterogeneous materials, forming a single structure of united parts, and giving a high degree of resistance. The main girders are reinforced with several sets of rods and may be given any desired form. (Figure 14.) Such girders

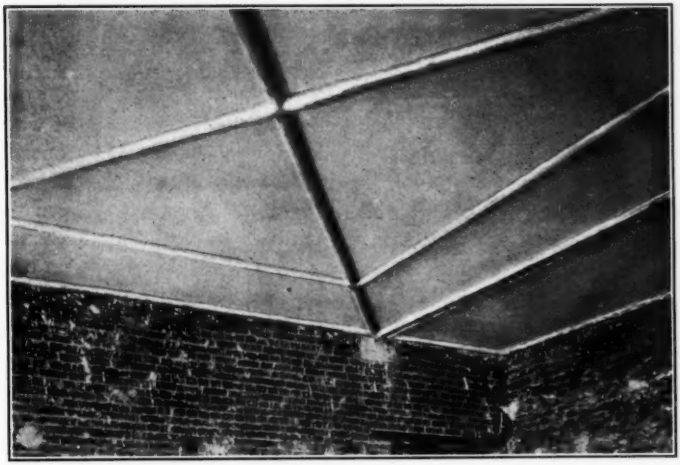


FIG. 13. SLABS OF CEMENT LET DOWN, FORMING A CEILING, COTTANCIN SYSTEM.

are constructed to sustain loads of 5,000 to 10,000 kilogrammes per superficial metre. The secondary beams (*a*, Figure 15,) which are united with the main beams, are reinforced by two or four rods and are capable of sustaining 2,000 to 3,000 kilogrammes per square metre. Finally the arched filling *b*, between the secondary beams, which is also reinforced with light rods and stirrups, is capable of resisting a load of 200 to 3,000 kilogrammes per running metre. This filling constitutes a continuous flooring independently of the beams, and is capable alone of spanning the spaces usually occurring in residences and similar buildings. For large public buildings and industrial establishments, however, it is necessary to use beams of reinforced concrete to span the large openings and support heavy loads without intermediate supports.

In the Hennebique system it is usual to mould the concrete entirely in place. For this purpose there is erected a scaffolding of the shape of the beams and arched filling. Sometimes, however, it is practicable to use a system of separate floors and ceilings, in which case the various parts can be made elsewhere and assembled in place; but in all instances the beams are constructed in place.

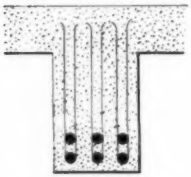


FIG. 14. MAIN GIRDER, HENNEBIQUE SYSTEM.

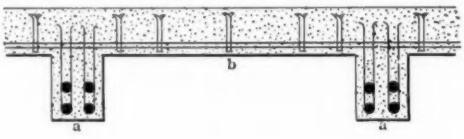


FIG. 15. a a, SECONDARY GIRDERS; b, CEILING FILLING; HENNEBIQUE SYSTEM.

Walls and Partitions:—The question of the construction of walls and partitions has been ingeniously solved by M. Cottancin. Concrete itself is not altogether suitable for vertical partitions, since the softness of the fresh material and the difference in density between the cement and the sand prevent the construction of a thoroughly homogeneous mass. M. Cottancin therefore employs hollow bricks in connection with the metallic reinforcement. (Figure 16.) The reinforcing rods pass through the vertical openings in the hollow bricks, as well as between the horizontal joints, the two systems of rods being interwoven with each other. If the partition is required to be very strong, it is composed entirely of bricks, with spine reinforcement, while for light dividing walls a limited number of bricks may be used, the intervals being filled in with blocks of plaster or con-

crete. M. Cottancin has erected the façades of houses 5 or 6 storeys in height by using double walls of bricks 5 centimetres thick, reinforced with the spine construction already described for floors. M. Monier constructs partitions upon a skeleton which is interwoven with those of the floor beneath and the beam overhead, when the location permits. Under such conditions the partition forms a sort of deep

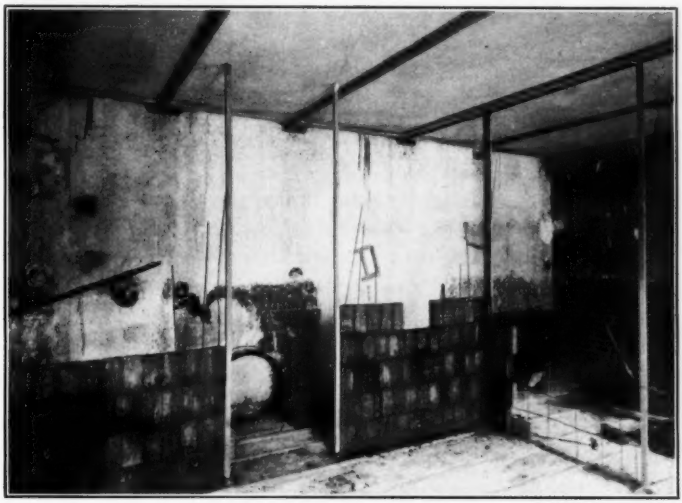


FIG. 16. PARTITIONS OF BRICK AND REINFORCED CONCRETE, COTTANCIN SYSTEM.

lattice girder, adding materially to the strength of the floor. M. Wayss has proposed to give the horizontal reinforcement rods of the partition a slight degree of curvature. (Figure 17.) This distributes the load over a greater portion of the reinforcing metal of the floor beneath. These horizontal rods are permitted to enter a certain depth into the floor and ceiling, in order to secure a more complete union between the various parts of the construction. The partition is completed by placing temporary board partitions each side of the reinforcement, and filling the space with concrete. Especial care should be taken in this operation to insure that the concrete penetrates between the interstices of the network. Some constructors prefer to use but one temporary board partition, applying the concrete upon and through the network from the other side, and watching to avoid the formation of gaps or voids. By using concrete of moderate consistency this can be effectively done with the trowel. The metallic reinforcement is in all cases secured to the wall masonry by loops or other suitable fastenings.

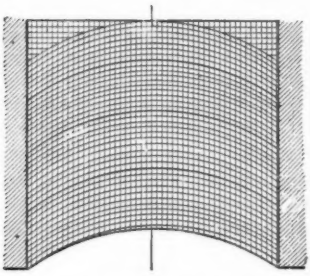


FIG. 17. PARTITION REINFORCEMENT, WAYSS SYSTEM.

In the Hennebique system the partitions are from 8 to 12 centimetres in thickness. These are moulded between boards. The vertical rods are placed in position, and the wall is filled up on one side. The horizontal rods are then placed in position, and the filling of concrete completed. (Figure 18.) Three arrangements are practicable, according to circumstances. When there is a vertical load it is important to prevent bulging, and the vertical rods are arranged alternately near each side of the wall, the stirrup-irons being placed so as to add to the strength of the mass. When a pressure from one side is to be resisted, the vertical rods are placed near the opposite side, the strength being made proportional to the estimated pressure at each portion. For partitions which may be subjected to pressure from either side, the forces are computed separately and the rode on each side are made strong enough to resist the alternate pressures.

Roof Construction:—The various methods of employing reinforced concrete present numerous advantages for roof construction. The old design of Mansard roof is very hot in summer and cold in winter, while the use of a double wall of reinforced concrete, such as that of the Cottancin system, renders this portion of a house habitable. In like manner the use of arched-roof construction in reinforced concrete enables wide spans to be covered in industrial buildings or halls and meeting places. Dormer windows or skylights can be constructed in such roofs, forming a portion of the complete structure without weakening the whole, and at the same time affording excellent opportunities for decoration and ornament. The entire complication of frameworks or truss construction is eliminated, so that a roof of the Mansard type can be built of large spans in reinforced concrete, especially if double ceilings are employed with connecting reinforcement, this constituting

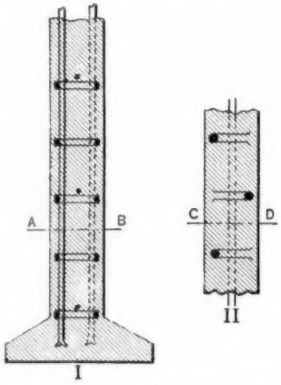


FIG. 18. PARTITION WALL, HENNEBIQUE SYSTEM.
I, section on CD. II, section on AB.

a series of lattice beams as A B, D C, E F, Figure 19. Light rafters can then be placed upon these supports, carrying a roofing of zinc, and the circulation of air thus permitted makes the space beneath cool, while the rooms below are protected by the solid ceiling K E, of reinforced concrete.

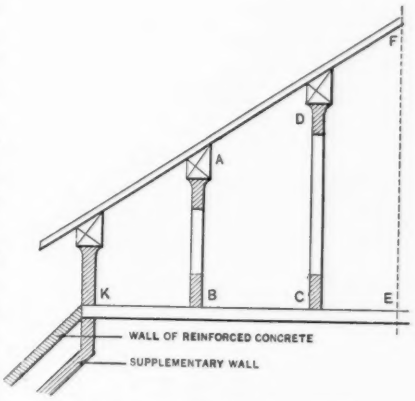


FIG. 19. ROOF, COTTANCIN SYSTEM.

It is entirely practicable to leave the concrete ceiling visible, but where an artistic finish is desired this construction lends itself admirably to ornamentation in ceramics or colored glass, or it may be plastered and tinted.

In the application of the Monier system to roof construction the rafters and purlins are replaced by slabs of reinforced concrete which

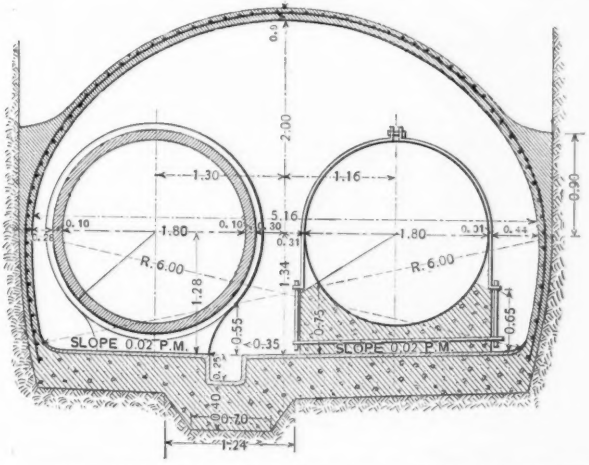


FIG. 20. REINFORCED-CONCRETE TUNNEL BUILT BY M. BONNA FOR CARRYING THE ACHÈRES SEWERS.

replace the usual frames. These are used for wide spans, the horizontal thrust upon the walls being taken up by suitable tie-rods. The other systems present no peculiarities in their applications to roofs.

FIG. 21. LAYING REINFORCED-CONCRETE DRAIN, BONNA SYSTEM.

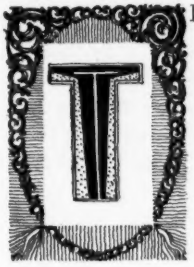
Arches and Tunnels:—The construction of tunnels is naturally somewhat similar to that of pipes, but the section is usually elliptical or three-centred. In the construction of the drainage works for the city of Paris at Achères M. Bonna has employed a depressed arch. The tunnel, Figure 20, is elliptical in section, 5.16 metres in width and 3.34 metres high. The total length is 2.5 kilometres and it contains two mains of 1.80 metres in diameter. The skeleton is composed of a lattice of rods spaced 11 centimetres apart, one set following the elliptical curve of the arch, the other being longitudinal. The rods are of round steel 15 and 18 millimetres in diameter respectively, and are united at the intersections by iron wire. The whole is imbedded in a mass of concrete 8 centimetres in thickness. When it was desired to render any portion of the tunnel water-tight, a thin sheet of lead was placed over the first layer of concrete and held in place by light iron hoops, the full layer of concrete being then applied.

Arches of various forms are constructed in the same manner as floors. Since they may be made much thinner than when built of bricks or masonry, they are very useful when the head room is contracted. Arches of reinforced concrete have also been found very valuable in military engineering, in connection with fortification work, involving a maximum resistance for the mass employed.

THE ECONOMY OF ISOLATED ELECTRIC PLANTS.

By Isaac D. Parsons.

The active interest of an actual cost comparison between isolated-plant and central-station electricity supply needs no enforcement beyond that given in Mr. Parsons' opening paragraph. The striking point is that a thorough investigation of more than two hundred and fifty isolated plants discovered only seventeen in which cost records were full and reliable. The following article therefore represents a remarkable concentration of valuable figures—the most interesting compilation of exact data in this field we have yet seen.—THE EDITORS.



THE relative economy of generating electricity in an isolated plant and of obtaining it from a central station has for some time been an undecided question. The rapid increase—especially in the large cities of the United States—in the number of immense buildings, including hotels, office buildings, and apartment houses, lighted entirely by electricity and in which the elevators and ventilating fans are operated from the same source, makes the solution of this question to-day a consideration of great importance. The universal employment of steam for heating and the growing number of refrigerating machines in use rendering the installation of a steam plant necessary, as well as the increasing size of the buildings, tend to encourage the introduction of the isolated plant and to increase its economy. At the same time, the conditions prevailing in some buildings, such as clubs, apartment houses, and hotels, where freedom from noise and vibration is a prime requisite, may tend to discourage its introduction and lead to the adoption of the central-station supply.

The following investigation was undertaken by the writer and Mr. Arnold von Schrenk in an attempt to ascertain which of the two methods is the more economical in six classes of buildings in New York, and to determine as nearly as possible those conditions, either inherent in a class of buildings or due to peculiarities of installation or management which materially influence the economy. The six classes referred to are:—Office buildings, loft buildings, department stores, apartment houses, hotels, and clubs, and over two hundred and fifty buildings were visited in the effort to obtain reliable figures and to ascertain the various conditions of operation. Of this number seven-

teen only were found where information could be obtained which was reliable in every particular, and only these will be considered in detail, as the great variation in conditions even among similar buildings of the same class renders incomplete statistics of very doubtful value.

The figures as to electrical output of each of these plants were obtained from wattmeter readings or from hourly ammeter readings and were verified by personal observation of the instruments from which they were obtained, and were also checked by comparison with other buildings were similar conditions exist. In some cases, tests were made of the instruments to determine their accuracy. The figures recorded as the output of a plant are in every case the total number of kilowatt hours supplied at the switchboard and used as light or power, and where a storage battery was installed its output only was considered. The expenses of the plants were divided into those of labor, gas, central-station auxiliary or breakdown service, coal, water, ash cartage, oil and waste, repairs, incandescent lamps and arc-lamp carbons, interest, depreciation, and sundry supplies not included in the foregoing. Figures concerning these items were obtained in most cases directly from the books of the chief engineer or owner, and may be considered within very small limits absolutely accurate. Under the item labor are included the wages of all the engineers, firemen, oilers, and coal passers employed in the plant, excepting in a few cases where extra employees were required by a large refrigerating machine or similar apparatus. In these cases the wages of the extra men were deducted from the total. If it were determined what employees could be dispensed with were the plant not installed, and the wages of these men only were taken, it would give the true cost of labor chargeable against the plant. To decide this, however, was in most instances a rather uncertain and difficult problem and it was thought fairer to include in the expenses the wages of all the employees, which, with the other items, give the total cost of running the building with a plant. Then by adding to the expenses of the central-station service the cost of the labor necessary for heating, elevator supervision, etc., the total cost of running under the conditions of central-station supply can be found. The difference between the two results is the true amount gained or lost by the installation of the plant.

The item coal includes that which is burned to generate the steam used for the engines driving the generators, for the feed pumps, and in most cases that used for the house pump and whatever live steam is used in heating the building. In many buildings, refrigerating machines, steam laundries, steam cooking apparatus, or pumps, received

steam from the same boilers as the engines driving the dynamos; but in such instances figures from recent tests were available by which the amount of coal used for these purposes could be determined.

With the central-station supply either a boiler or a connection with the street mains is required to obtain the steam necessary for heating the building, as well as for the hot-water supply and for running the house pump, unless it is operated electrically. To determine what extra sum must be added to the actual cost of current in order to find the total expense of running the building from the central station, figures were obtained from two large loft buildings, an office building, and six apartment houses and hotels using steam for heating and for house pumps only, from which the cost of coal, labor, and water required for these purposes could be calculated. The expenses for coal were reduced to dollars per 1,000 cubic feet heated, and showed practically constant factors, irrespective of the shape or size of the building, of $1.10 per 1,000 cubic feet for apartment houses, 90 cents per 1,000 cubic feet for office buildings, and 40 cents per 1,000 cubic feet for loft buildings. The cost of labor, which includes the wages of the firemen and the expense of elevator supervision, has to be determined in each particular case, but usually amounts to a sum about equal to the cost of coal.

Interest was calculated in all cases at 5 per cent. on the principal invested in the plant. Depreciation on dynamos, engines, and switchboards of 5 per cent., and on boilers, pumps, and steam piping of 8 per cent., was considered liberal; and since, as a rule, the cost of the dynamos, engines, and switchboards approximates two-thirds of the total cost of installation, and that of the boilers, pumps, and steam piping one-third, a uniform rate of $10/3 + 8/3$, or 6, per cent. was charged against the whole plant. If 5 per cent. of the original capital invested in the engines is set aside each year as a sinking fund, this sum will accumulate interest at 5 per cent. and at the end of fourteen and one-half years the total of the amounts reserved, with compound interest, will equal the original cost of the engines; so that 5 per cent. depreciation assumes a life of but fourteen and one-half years. Similarly 8 per cent. depreciation on boilers assumes a life of ten years. As a matter of fact, both of these periods are much exceeded in first-class modern installations. On storage batteries, where depreciation is a somewhat doubtful quantity, it was taken as 10 per cent., which assumes a life of but seven years. The load factor in every case was calculated for the hours the plant was in actual operation.

As regards load and other conditions of operation, all the buildings

All buildings heated by steam. All engines non-condensing and direct-connected to the generators.

Building number	1	2	3	4	5	6	7	8
Type of building	Office	Office	Office	Office	Office	Loft	Loft	Loft
Number of floors	11	over 20	13	15	12	12	12	10
Ground plan	50x120	70x100	60x150	75x100	40x100	200x176	100x100	40x200
Number of electric elevators	4-25 h.p.	10-25 h.p.	6-27 h.p.	8-30 h.p.	3-20 h.p.	15-20 h.p.	4-20 h.p.	4-25 h.p.
Part of building lighted	All	All	All	All	6 floors	All	All	All
Type of engine	Simple	Comp'd	Comp'd	Simple	Simple	Simple	Simple	Simple
Number of generators	4	4	5	3	1	3	3	3
Total capacity of generators, kilow	260	575	475	300	40	300	260	90
Average load on generators	.55	.75	.75	.90	.65	.90	.75	.60
Voltage	220&240	120	115&240	116	240	240	240	240
Type of boiler	H. Tub.	W. Tub.	Water Tube	H. Tub.	H. Tub.	H. Tub.	W.Tub.	H. Tub.
Boiler pressure	90	125	115	100	95	90	100	100
Back pressure	0	0	1 to 3	4	1 to 5	3 to 9	2 to 5	7 to 10
Kind of coal	Pea	Buck.	Buck.	Pea	Buck.	Rice	Buck.	Buck.
Capacity storage battery, amp. hrs	.....	3500	.....	3000	300	.....	.....	.....
Load factor of lighting load	.24	.43	.72	.....	.87	.70	.45	.....
Cost of light, heat and power with plant installed.								
Time covered by figures	1 year	1 year	9 mos.	1 year	1 year	1 year	1 year	1 year
Labor	$2,460	$7,228	$6,750	$9,000	$6,318	$1,484	$4,628	$4,776	$1,662
Coal and removal of ashes	2,758	10,070	7,663	10,238	9,174	1,012	4,192	2,736	2,129
Water	254	776	756	1,004	900	97	446	204	270
Oil and waste	181	287	171	215	128	103	193	108	80
Lamps	120	600	338	450	420	44	233	33	57
Repairs and sundries	183	50	429	568	65	295	100	108	478
Interest and depreciation	1,340	10,420	3,630	4,840	5,365	1,274	2,200	2,730	908
Central station service	1,370					225		300	579
Total	$8,666	$29,431	$19,737	$26,315	$22,370	$4,534	$11,992	$10,995	$6,163
Output—light K. W. hours	91,804	409,233	395,949	550,000		18,123			
" —power K. W. "	59,760	266,344	160,963	225,000		48,437			
" —total K. W. "	151,564	677,577	556,912	775,000	721,301	66,560	379,939	143,320	130,000
Cost per K. W. hour	$0.057	$0.044	$0.034	$0.034	$0.031	$0.068	$0.032	$0.077	$0.047
Tons of coal consumed	919	3007	2250	3012	2619	337	1873	863	835
Lbs. coal per K. W. hour	15.5	10.0	9.1	.....	8.2	11.4	11	13.5	14.4
Probable cost of light, heat and power for same period if no plant installed.									
Central-station bill	$12,374	$28,000	$22,300	$31,000	$29,500	$5,307			$6,500
Labor	1,000	3,600	2,700	3,650	3,600	1,136	$1,840	$1,740	1,600
Coal	660	1,800	700	1,070	1,080	877	920	765	
Total	$14,034	$33,400	$25,700	$35,720	$34,180	$7,320			$8,100

TABLE I. DATA OF ISOLATED PLANTS.

can be divided into two classes—those used for business purposes, such as office and loft buildings and stores, and those which are used for residential purposes—such as hotels, apartment houses, and clubs. In the former class, a small uniform lighting load during most of the day is succeeded at about 3 p. m. by a heavy load lasting but a few hours, which after 7 p. m. again becomes very small. In the latter class the heavy load, instead of falling off in the evening, continues to 1 or 2 a. m., giving a more uniform load and a higher load factor. We will consider the business buildings first.

Building No. 1 is an office building having a large store on the ground floor. The dimensions of this building, as well as a general description of its plant, are given in Table 1. Very complete daily records are kept of all supplies and of the output. The kilowatt hours used for lighting are obtained from hourly ammeter readings, and the power required for the four electric elevators is calculated by multiplying the total number of minutes the elevators are in actual operation, which is recorded automatically by an instrument attached to each elevator, by the average kilowatts consumed per minute, found from previous tests. Steam is used only for the engines driving the dynamos and for small house and feed pumps. The generators are started at 8 a. m. and stopped at 8 p. m., current being obtained during the night from the central-station. The expenses of operating the plant and the electrical output for one year are shown in the table. The 19,293 kilowatt hours which were obtained from the central station are included in the above output. Were these kilowatt hours deducted from the output and $1,370, the amount paid for them, subtracted from the expenses, the cost per kilowatt hour would be reduced to $0.055. Calculated at prevailing wholesale rates, the total amount of electricity used in this building during the year, (151,564 kilowatt hours), would cost, if purchased from the central station, $12,373.78, with all discounts allowed for. With central-station service, heating the building and supervision of the elevators would necessitate the employment of one man for the whole year and another during the winter months, making the labor expenses about $1,000. Judging from similar buildings, coal for heating would amount to 220 tons, so that there would be a total expense for heating, etc., of $1,700 a year. This sum added to the above figure for central-station service brings the total cost of running the building under these circumstances to an amount which is $5,400 more than the cost of operating the plant.

The increased amount of coal burned in this building during the winter months, due to heating, is shown by the curve in Figure 4.

In the large office building (No. 3) for which a similar curve is given in this figure, the great volume of exhaust makes necessary the use of very little live steam for heating and consequently the coal burned per kilowatt hour is practically constant throughout the year. The curves of Figure 1 show the maximum and minimum demand for light in this building during the year.

Building No. 2 is one of the largest office buildings in New York and contains a little over 2,000,000 cubic feet. Tested wattmeters on both power and light circuits enable absolutely correct daily readings of the electrical output to be obtained and data of the expenses of operating the plant were procured from the books of the chief engineer and superintendent. The ten electric passenger elevators are in operation daily from 8 a. m. to 6 p. m. In addition to the quantity employed in

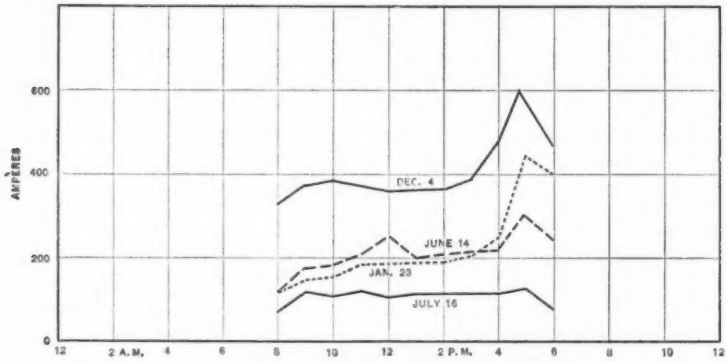


FIG. 1 MAXIMUM AND MINIMUM LIGHTING LOADS IN A SMALL OFFICE BUILDING (NO. 1) DURING THE SUMMER AND WINTER MONTHS

the generation of electricity, steam is used for a 25-ton refrigerating machine, for a laundry, for steam cooking apparatus, and for several large pumps. The coal consumed to generate steam for these machines during the year 1900 was found by tests to be 989 tons, and since the coal consumption for the year for all purposes was 3,996 tons, 3,007 tons are chargeable to the electric plant and to heating. The employees are three engineers, four firemen, and three oilers, but since one fireman and one oiler would not be required were it not for the refrigerating machine, etc., mentioned above, the wages of these two men are not included in the expenses of operating the plant. The output and expenses for the year 1900 are given in Table 1. The cost per kilowatt hour, $0.044, is not very low for so large a plant working under such favorable conditions as to installation. Central-

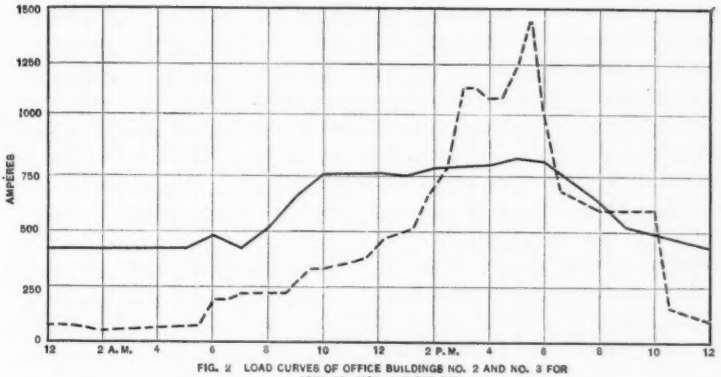


FIG. 2 LOAD CURVES OF OFFICE BUILDINGS NO. 2 AND NO. 3 FOR APRIL 27, 1901, A CLEAR DAY.

station rates for this enormous quantity of electricity, while they might not be quite so low as $0.044, would not be far above it and the gain by the isolated plant is, in this case, small. Figure 3 shows the change in average daily load from month to month and Figure 5 the great variation in the lighting load from day to day during three characteristic months. The variation of the power load is small.

Building No. 3 is an office building having about 60 per cent. of the cubic contents of building No. 2 Statistics of the lighting output were obtained from half-hourly ammeter readings and the power consumed by the elevators was accurately ascertained. In addition to the electrical machinery, several large pumps and three steam elevators are installed, and the amount of coal used by them was accurately determined during two weeks use of the central-station ser-

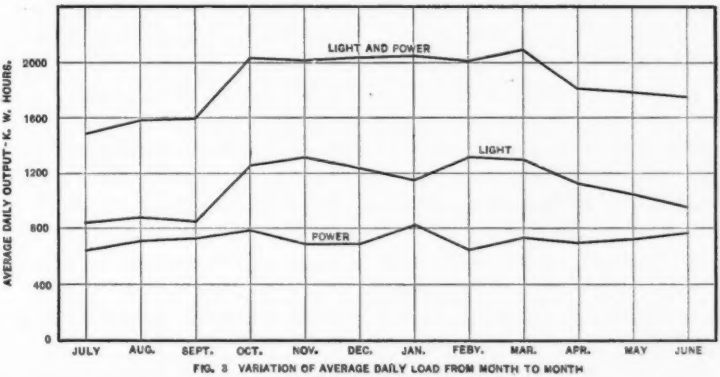


FIG. 3 VARIATION OF AVERAGE DAILY LOAD FROM MONTH TO MONTH IN LARGE OFFICE BUILDING (NO. 2)

vice. Figures of kilowatt-hours output unfortunately could be obtained for only nine months, from May to January, inclusive. During that period the total coal consumption was 3,003 tons, of which 74.9 per cent., or 2,250 tons, were chargeable against the electric plant. The expenses and output of the electric plant and the probable cost of heating the building and of elevator supervision for nine months are given in Table 1. The yearly expenses are also given, that they may be more easily compared with those of the other buildings.

The cost per kilowatt hour is far below the central-station rates and the use of this service would be out of the question since it would mean an increased annual expense of $9,000.

A comparison of the expense account of this and of the preceding building shows that, except for the item of interest and depreciation, they agree quite closely, so that in this item must lie the main reason for the difference in economy. For the dissimilarity of this item in the buildings in question there are two reasons:—

First, the lighting load in the smaller building is more favorable to the isolated plant than in the larger building, as may be seen by comparing the load diagrams in Figure 2. Building No. 2 has few dark offices and is little used at night, so that excepting for the high peak between 3 and 6 p. m. the lighting load is small and at night is carried by the storage battery. The high peak, however, necessitates the installation of generators of large aggregate capacity, most of which are very little used. In building No. 3 there are a number of dark offices and the business pursued on several floors requires the use of much light throughout the night. The lighting load is thus more uniform than in building No. 2, and though heavier can be handled with smaller generator capacity. Besides, the expensive storage battery is absent. The power load is fairly uniform during the day in both buildings and at night is practically zero.

Second, in the large building the generators and storage battery have a combined full-load capacity of 5,150 amperes, though the maximum load never reaches 3,200 amperes, while in the smaller building genarators with an aggregate capacity of less than 2,900 amperes carry a load the maximum value of which is about 2,500 amperes.

Building No. 4 is an office building very similar in size to building No. 3. Its many dark offices cause a very heavy and fairly uniform lighting load so that, as in building No. 3, the total kilowatt-hours output exceeds the output in building No. 2. The eight electric elevators are in operation daily from 9 a. m. to 6 p. m. The output of the electric plant was obtained from hourly ammeter readings

and the figures of cost of operation were procured from the agent in charge of the building. Other than the feed pumps and the engines driving the generators, the only machines using steam were small pumps and steam cooking apparatus which use about 110 tons of coal yearly, an amount which was deducted from the total yearly coal supply of 2,729 tons, leaving 2,619 tons chargeable to heating and the generation of electricity. The expenses of operating the plant in the year 1900, as well as the probable cost of heating the building and of elevator supervision were no plant installed, are shown in Table 1. The cost per kilowatt hour is much below any rate the central station would offer and the gain in this building through the installation of the plant is probably $12,000 annually. A comparison of the expense accounts of the last three buildings shows clearly the advantage of the storage battery in reducing the cost of labor. In building No. 3, three full shifts of employees are required, since the generators are operated twenty-four hours a day, whereas two shifts only are necessary in

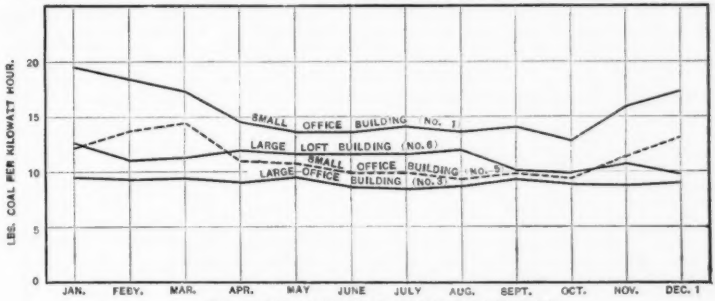


FIG. 4 MONTHLY VARIATION IN COAL PER KILOWATT HOUR IN OFFICE AND LOFT BUILDINGS.

the buildings where storage batteries are installed. In those buildings the generators are stopped from about 8 p. m. to 6 p. m. and the battery carries the load during that time.

Building No. 5 is a characteristic example of the modern small office building. Hourly ammeter readings enabled the output of both light and power to be calculated accurately. A very complete daily record of expenses also, including all items, was kept by the chief engineer. Coal in this building was used only for heating and for the generation of electricity. The great advantage of the storage battery is shown in this building, where if no battery were installed the elevators and lights would have to be supplied from separate machines to prevent fluctuations in voltage, which would require the installation of a 40-kilowatt machine for the elevators and a 20-kilowatt machine

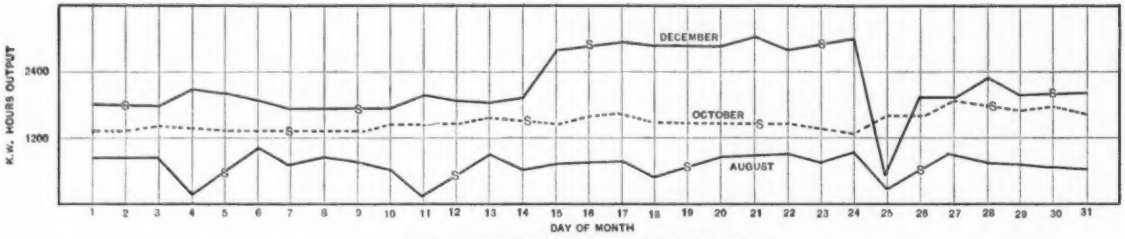


FIG. 6 VARIATION IN THE LIGHTING LOAD FROM DAY TO DAY IN A DEPARTMENT STORE (BUILDING NO. 9).

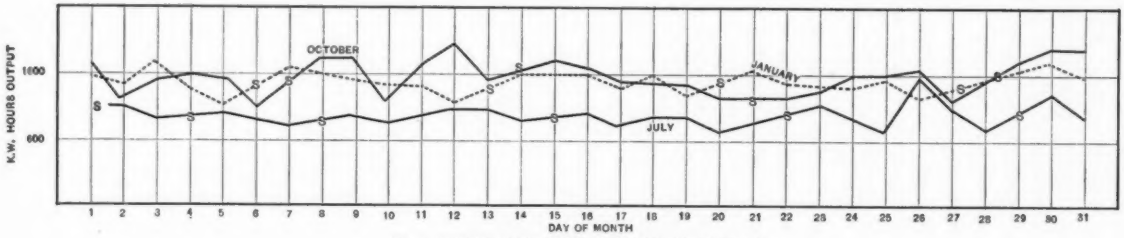


FIG. 5 VARIATION IN THE LIGHTING LOAD FROM DAY TO DAY IN A LARGE OFFICE BUILDING (BUILDING NO. 2).

S DENOTES WHERE DAYS OCCURED SUCH AS SUNDAYS AND HOLIDAYS, WHEN THE PLANT WAS NOT IN OPERATION.

for the lights. This would not only entail additional expense of installation, but neither machine would operate at an average load of more than half of its capacity. Moreover, if they were operated at night an increased cost of labor would result, and if they were not run at night the central-station bills would be higher than at present as the battery now carries the night load from about 8 p. m. to 6 a. m. The output and expenses of operating the plant are given in Table 1, as well as the expenses in addition to those of central-station services the year before the plant was installed. A comparison of the cost of running the building with and without the plant shows, with the same output, a balance in favor of the plant of nearly $2,700.

This concludes the data collected in regard to office buildings. As the five buildings cited include one of the largest office buildings in the city of New York, one of the smallest, and three buildings of average size, they cover the field fairly well. They indicate as a rule the marked superiority in economy of the isolated plant but, as shown in the case of building No. 2, a slight error in installation combined with unfavorable load conditions may, even in the very largest buildings, render the isolated plant of doubtful economy.

The next class of buildings to be considered is the loft buildings. In these buildings it is nearly impossible to decide what is the exact amount gained or lost by the installation of the isolated plant. Usually if the central-station service is employed, the owners of the building use a certain amount of the current for hall lights and for the elevators, if they are electric, and what electricity is used by the tenants for light and power is recorded on their wattmeters and paid for by them. The total amount of current is therefore split up into a number of separate items, each of which receives but a small discount, whereas the entire amount used in the building, taken as a whole, would be subject to a much larger discount. The difference between the amount which would be paid in the two cases increases, of course, with the number of tenants. Thus in a loft building of twelve floors where the total power consumed by the tenants is 9,000 horse-power hours per month, if each tenant occupied one floor and used on an average 750 horse-power hours (which is about the average amount used per tenant in this class of buildings) the rate would be $0.07 per horse-power hour. If, however, only three tenants occupied the entire building, each taking 3,000 horse-power hours per month, the rate would be reduced to $0.05 per horse-power hour. These conditions are very favorable to the isolated plant, especially when there are many tenants each using a small amount of electricity. Current can

profitably be furnished to them at a discount from central-station rates. The current supplied to the two or three lower floors of loft buildings is used principally for lighting, whereas in the upper floors less light is necessary and much power is used for operating sewing machines, heating irons, etc. This tends to make the average load heavier than in the office building and enables a plant to be operated more efficiently on account of the high load factor.

Building No. 6 is a large loft building, having a plant in the subbasement which supplies the power for the motors on the upper floors and for fifteen electric elevators, as well as current for lighting the building. A patent forced-draught system enables a cheap grade of coal to be burned with much advantage in the way of economy. Very complete daily records enabled the cost of production to be determined with great accuracy. No steam was used excepting for the engines driving the dynamos, for the feed pumps, for a small house pump, and for heating. The plant is in operation from 6 a. m. to 10 p. m. daily excepting Sunday. The expenses and output for one year are given in Table 1. The extremely low cost per kilowatt hour is due partly to the cheap fuel and partly to the high load factor. If the central-station service were employed, not only would it be impossible to make any profit from selling current to the tenants, but power for the elevators would have to be paid for at $0.067 per kilowatt hour instead of less than $0.032, and $2,920 yearly would be expended for heating the building and for elevator supervision as shown in the table. In Figure 8 are given the maximum and minimum loads carried by the plant during the year and Figure 4 shows the variation from month to month of the coal burned per kilowatt hour. The fact that there is no increase during the winter months indicates that the building is heated without the consumption of any extra fuel.

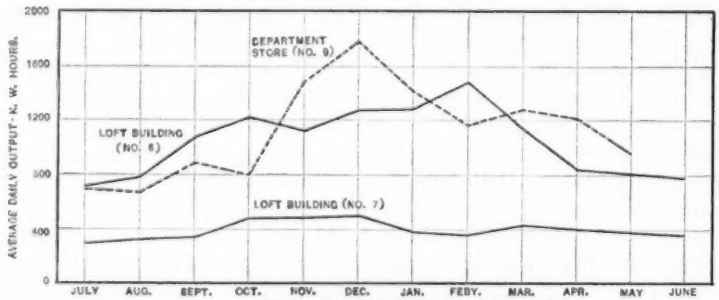


FIG. 7 VARIATION OF AVERAGE DAILY LOAD FROM MONTH TO MONTH IN LOFT BUILDINGS AND DEPARTMENT STORE.

Building No. 7 is used partly for lofts and partly for offices, only the six upper floors being used for manufacturing purposes. As in nearly all buildings of this class the wiring throughout is for the 240-volt two-wire system. The use of a potential regulator acting on the

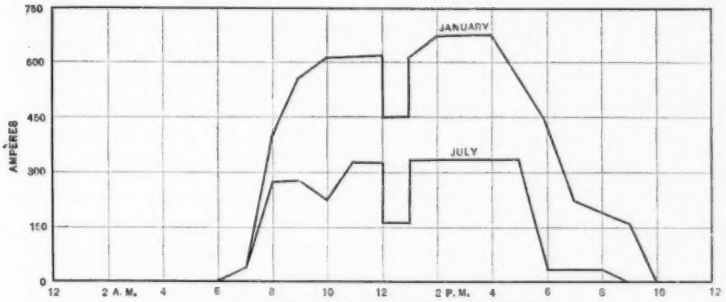


FIG. 8 MAXIMUM AND MINIMUM LOADS DURING THE YEAR LIGHT AND POWER COMBINED, IN A LARGE LOFT BUILDING. (NO. 6)

fields of the dynamos enables the same generator to be used successfully for both elevators and lights simultaneously. No machinery using steam was installed other than that ordinarily included in the electric plant. The generators are operated from 7 a. m. until 8:30 p. m., the building being lighted during the night by the central-station supply. Electricity for power and light is sold to the tenants at central-station rates. Figures concerning daily output were obtained from wattmeter readings, and the expenses were procured from the superintendent's books. For one year the expenses and output were as shown in Table 1. It will be noticed that both the labor and interest and depreciation items are large, the latter being due to the installation of an extra 100-kilowatt generator which makes the full-load capacity of the plant 1,000 amperes at 240 volts, though the maximum load never reaches 600 amperes. The variation from month to month of the average daily load in this building and in building No. 6 is shown in Figure 7. The sum received annually from the tenants amounts to about $7,500. This subtracted from $10,995 leaves $3,445, which is the actual cost to the owners of running the building under present conditions. Were the central-station service used entirely, the expenses of running the building would be approximately as follows:

Current for elevators at $0.05 per horse-power hour	$1,156
Current for hall and engine room lights	1,200
Coal for heating—225 tons	765
Labor: Engineer, 12 months, one fireman 12 months, one fireman 6 months	1,740
	$4,861

Building No. 8 is a loft building smaller than either of the preceding. Its plant furnishes current for the four electric elevators, for the various motors throughout the building, and for lighting. Electricity is supplied to the tenants at fixed rates during the time the plant is in operation (6 a. m. to 6 p. m.), but during the remainder of the twenty-four hours each tenant is supplied from the central station. Steam is used for the generation of electricity and for heating. The kilowatts output was obtained from ammeter readings, and the expenses from daily records. The expenses and output for one year are given in Table 1. The smaller cost of operation of the plant in building No. 8, as compared with No. 7, is due largely to the small labor item. Besides, in building No. 8 there are no spare dynamos, a fact which, though a disadvantage in case of accident to one of the machines, reduces the interest and depreciation charge to two-fifths of that in the preceding building. For 130,000 kilowatt hours yearly the central-station rate would not be below $0.05 per kilowatt hour, which would mean a saving by the isolated plant of $390 a year. The year previous to the installation of the plant the cost of heating the building and of elevator supervision was $1,600, which added to $390 makes a total saving by operating the plant of $1,990.

From the figures in regard to these three loft buildings it would seem that the installation of a plant in a building of this class and the sale of current to the tenants at central-station rates or, in very large loft buildings, at 10 per cent. to 25 per cent. reduction from those rates, would in most cases prove very profitable.

The department stores are the third class of buildings to be treated. Figures could have been obtained from several buildings of this class but the complications were such that in only one building were really accurate data of the cost of generating electricity available. Since the department store is however a special and limited class of building, one typical example is perhaps sufficient.

In most buildings of this class the uses of steam are almost as varied and numerous as they would be in a large town. Ice machines, steam laundries, steam cooking apparatus of many kinds, steam dish-washers, distilling apparatus, pumps of all sizes and varieties, blower engines and various other machinery, were found in almost every case and to determine the exact amount of steam used for these purposes was next to impossible. The steam used thus, furthermore, could not be ignored as it often formed nearly one-half of the total generated.

In the building which we will call No. 9, a steam laundry, steam cooking apparatus, one steam elevator, five hydraulic elevators, and a

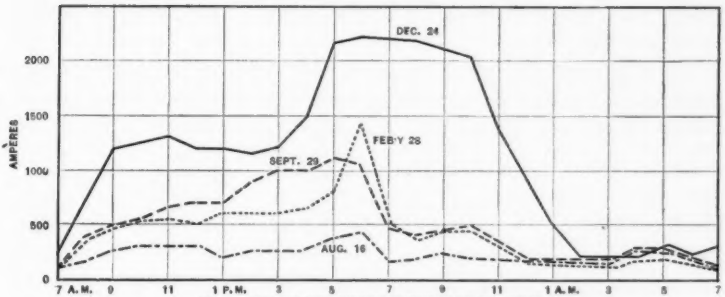


FIG. 9 MAXIMUM AND MINIMUM LIGHTING LOADS IN A DEPARTMENT STORE DURING THE SUMMER MONTHS.

large blower engine in addition to the electric plant received steam from the boilers. The electric plant had, however, been but recently installed and the amount of coal burned before its installation, when otherwise almost exactly similar conditions existed, could be obtained. This, with a knowledge of the amount of labor employed before the installation of the electric plant, enabled the extra cost entailed by its operation to be determined.

Building No. 9 is 5 stories in height and approximately 200 by 200 feet in ground plan. The plant consists of three generators having an aggregate full-load capacity of 2,400 amperes at 120 volts, direct-connected to simple engines. Steam is furnished for the electric plant and other purposes by horizontal tubular boilers rated collectively at 600 horse power. Buckwheat coal is used and the average pressure is 90 pounds. The dynamos are run usually throughout the twenty-four hours, and are only stopped on Sundays and holidays.

The output which is used for lighting only was calculated from hourly ammeter readings. The expenses of operating the plant were obtained from the chief engineer's books, and figures concerning the expenses the year before the electric plant was installed were procured from the books of the firm. The load on the dynamos averages during the twenty-four hours about 75 per cent. of their capacity, and the load factor varies between a maximum of .70 in July and August and a minimum of .30 in October, November, and January, the average for the year being about .56. This is higher than in most office and loft buildings, which fact is due to the comparatively large amount of light used during the day for decorative purposes in the department store, and to a load of about 225 amperes continuing throughout the night.

Figures, unfortunately, were available for seven months of the year only, from August to February inclusive, but as these include the

months having both the heaviest and the lightest loads they are fairly representative of the yearly average.

Table 3 shows the operating expenses during seven months of the year, before the installation of the electric plant, and also during the same seven months of 1900 when the electric plant was in operation.

	Before plant installed.	After plant installed.	Difference.
Labor	$2285	$3822	$1537
Coal	2227	5436	3209
Water	200	488	288
Oil and waste	100	236	136
Lamps	—	171	171
Repairs and sundries	—	86	86
Int. and depreciation	—	2440	2440
Total	$4812	$12,679	$7867

TABLE 3. EXPENSES FOR 7 MONTHS—BUILDING NO. 9.

The output during the seven months of 1900 was 244,259 kilowatt hours which makes the average cost per kilowatt hour $0.032. This cost does not include the expense of heating, which is allowed for in the coal deducted from the total. The increase in the amount of coal used, due to heating, is, however, small, since the heating is done almost entirely by the exhaust. Were the electric plant alone installed the labor item would probably be $3,450, since only one man of the present force could be dispensed with. It we substitute this amount for $1,537, the expenses will be reduced to practically the same basis as in all the preceding buildings and the resulting cost per kilowatt hour is $0.036, which includes the cost of heating. The cost of 244,259 kilowatt hours if purchased from a central station would be about $11,000, which shows a very great advantage in the installation of the isolated plant, and with the two important points in its favor that the average load factor is quite high and that a steam plant is a necessity whether the electric plant is installed or not, there seems little doubt of the advisability of its installation in the department stores.

Figure 9 shows the maximum and minimum loads carried by the plant in building No. 9 during the year. The very heavy load on December 24 is due to the store being open in the evening, and to the use of many extra lights. The variation of the average daily load from month to month is shown in Figure 7, and the difference in load from day to day for three characteristic months in Figure 6.

Nearly all the "business buildings" of New York would, as far as load conditions are concerned, come within one of the three classes which have been discussed. The discussion of the buildings used for residential purposes will be taken up in the next article.

EDITORIAL COMMENT

MR. LONGMUIR'S thoughtful article, which leads this issue, is remarkable for its breadth of vision in surveying the industrial field—for the soundness of its philosophy in explaining industrial phenomena by sociological causes. In the individual and family ideals of the working community are to be found fundamental influences affecting national destiny. The nation, in war, or in manufacture and commerce, is what its workmen are capable of making it, and their capacity is in the main directly proportional to the quality of their food, their personal surroundings —in short, their physical and mental nourishment.

* * *

SIR HIRAM MAXIM, writing in this Magazine in 1897 and again in 1898, pointed this out very clearly by a comparison of the British islands, and western nations generally, with the nations of eastern and southern Europe. Because the Briton was freer, better fed, better housed, better taught, better endowed with ideals of cleanliness and order, he met and overcame the supposedly overpowering sea-forces of the Spaniard in the time of Queen Elizabeth. Persistence in their respective tendencies made the disparity in efficiency between Northern and Southern blood even more apparent when the Spanish and American fleets met off Santiago. And, as Sir Hiram urged, this was so in large measure because war has become a matter of using highly adapted mechanical appliances and wielding huge mechanical forces, operations demanding educated intelligence—that is, a good order of nerve fibre and brain cell, the product of proper nourishment, hygienic living, and suitable exercise; or in other words, of an advanced state of widespread material civilisation.

* * *

SIR HIRAM chose military instances merely because they were most concretely impressive. They serve only to point conclusions to be applied far more widely through the whole range of engineering occupations which make up national industry. The same conditions which make a good gunner will make a good artizan. Mr. Longmuir starts, then, on sure foundations when he seeks to better Britain's position by raising the physical condition, and with it the aspirations, of the British workingman.

* * *

THE question immediately presented to employers is whether they are not suffering decay to set in at the bottom of the industrial structure. With the growth of works, the disappearance of personal contact between master and man, the rise of a distorted idea of individual independence which is actually selfish indifference—the lives of employer and employee (at least, during a cycle which is perhaps happily swinging back to better things) have been drawing farther and farther apart. At the same time, the pressure of life has been constantly rising, especially in towns, where so many of the mechanical industries are situated. The problem of housing, which in itself covers some of the most important influences on the physical and mental stamina of the individual, is becoming particularly difficult, and the compres-

sion cramps most those who are singly least able to resist—the working classes. Most employers would say, no doubt, that they cannot take knowledge of the home surroundings of their working people. But it will prove that they can and they will if they are convinced that, under present conditions, one of the chief elements of past success is decadent. Mechanical labour is scarcely beyond its second generation. The blood of the sturdy English yeoman, of the keen Yankee country lad, was its vital fluid. How long can this endure the de-oxygenating and de-vitalizing atmosphere of a low-plane city life?

* * *

IN his article on "The Location of the Shop—Shall it be City or Country?" in THE ENGINEERING MAGAZINE for April, 1896, Mr. H. L. Arnold referred to the better quality of country labour, but to the general preference of manufacturers for a city location on account of the greater flexibility of volume of labour which it permitted. The past five years have seen a remarkable spread of interest in the comparatively new institution designed to combine the advantages of both situations—the industrial community—described, in type and in many succesful working examples, by Mr. Patterson in the Works Management number of THE ENGINEERING MAGAZINE (January, 1901), and by Mr. Going in the issue of the Magazine for April last. At first glance this looks like a return to the paternalism of an earlier order of labour relations, but the likeness is superficial only. There is no sacrifice of independence on the part of the employee nor assumption of control on the part of the employer in these manufacturing villages, planned and built as an integral part of the manufacturing enterprise. The managers of the works, as Mr. Going suggests in his article above referred to, act merely as trustees of the interests of the workmen in securing land for them on terms as favourable as they make for the works; they act merely with the same consideration which an honourable active partner displays for an absent one—the same joint regard for the minority interest which the majority stockholders of an incorporated company are morally and legally bound to show.

* * *

THE motive of this newly reawakened care for the physical and mental well-being of the workingman is by no means simply philanthropic. It is the clear conviction, tersely expressed by Mr. Orcutt in his review of "Machine-Shop Management in Europe and America" in this Magazine during the first half of 1899—the conviction since confirmed by Mr. Patterson in our Works Management number—by Mr. Canniff, writing of the handling of railway men in our pages last April—by Mr. Going, discussing arbitration in THE ENGINEERING MAGAZINE for February, 1901—by Sir Benjamin Browne, and Mr. Cokely, and Mr. Roland and the late Mr. Slater Lewis, and in fact every advanced thinker on labour problems who has written in this Magazine—the conviction that *it pays* to enable the worker to keep himself well housed, well fed, well provided with hygienic necessities, well trained in the elements of knowledge on which his work depends and in the practical use of his faculties. Strange that it should take argument and a sort of *renaissance* of industrial science to convince the world that propositions it would accept as axiomatic, applied to a horse, are true when applied to a human worker! And as competition becomes more severe, the question becomes not one of adding to profit by increasing the output-capacity of the worker, but of averting loss of trade; for this loss will surely be the penalty of neglect to uplift the physical, mental, and moral standards and environment of the factory employee or operative.

In Britain the conditions of land tenure fill the problem with difficulties not met with in America—difficulties which may well deter an industrial manager otherwise fully convinced of the desirability of transplanting his works and his employees to a broader and freer site. How grave the "landlord incubus" has become in its effect on British industrial conditions is broadly sketched by Mr. Phillips in his study of "Britain and Her Competitors in Iron and Steel Making" (The Engineering Magazine, May–June, 1901). It is not likely, as Mr. Phillips suggests, that any radical change will be made in this matter by Parliamentary legislation in the near future. The extension to England of the measure passed for the relief of Ireland, which has in large measure settled the "Irish question," is not soon to be anticipated, but industrial interests quite as strenuously as agricultural interests demand that Britain shall speedily adjust her land system to principles of "occupying-ownership." Meantime it is the more incumbent upon the owners of large works, who are in position to secure the fee of land sufficient for their purposes, to see that provision is made for housing their work people. They can with little difficulty make arrangements which their workmen are unable to carry through individually and unfitted to undertake collectively. The settlements at Bourneville and Port Sunlight instance what can be done by enlightened management in this direction.

* * *

The striking difference between Mr. Longmuir's philosophy and that of the trade unionists is that he would level mechanical labour up from the bottom, while they would level it down from the top. The difficulty of the relatively low productive capacity of many workers—a difficulty admitted by labour economists generally—he would relieve by increasing their productivity through better nourishment and cultivation, thus bringing them nearer to the standard of their abler fellows. The trade unionist would meet the same situation by limiting the output of the more capable worker so as to lower him nearer to the level of his under-powered neighbour. Sir Hiram Maxim quotes one of his foremen as saying: "'If the strong and healthy men do more work than our weaker comrades are able to do, what is to become of our weaker comrades?' He pointed out that * * * it 'was necessary for the stronger and more skilful mechanics to reduce the output to the rate at which these less favoured brethren were able to do it.'" It is really a question which is most striking—the generous altruism inspiring the proposal, or the hopeless fallacy of the conclusion reached. It is hopeless because it attempts to ignore the whole principle and process of evolution—because it attempts to reverse the course of natural development. It is fallacious because it assumes the false premise that the condition of the least fit will be relieved of its disadvantages if the fittest will only sacrifice or decline to profit by their fitness. If the proposed measures could be carried out, they would surely lead to rapid degeneration and ultimate extinction of the race. Mr. Longmuir's proposal, on the other hand, leads broadly and steadily upward, harmonising with and accelerating the movement of evolution by making more individuals more fit to survive.

* * *

The amusing vagaries of the little primer of the Portuguese language entitled "English as She is Spoke" have frequently been commented upon, but they will bear referring to once more in connection with some of the peculiarities in the use of other languages in engineering and technical publications. Thus the well-known German company for the manufacture of electrical machinery, the Allgemeine Elek-

trizitäts Gesellschaft, some time ago issued a very handsome catalogue illustrating and describing the various electric stations designed and built by them in Berlin. This catalogue was reviewed at length by an engineering journal of high reputation, and in the review these various stations were described as having been "designed and constructed by Geplant und Erbaut, of the Allgemeine Elektrizitäts Gesellschaft." The existence of these two distinguished engineers must have been a revelation to the men who actually did the work, and it seems curious that they have not been heard of since on either side of the Atlantic.

Another instance, and this in the columns of a well-known electrical paper, is the information that certain three-phase generators at the Paris Exposition were exhibited by Messrs. Electricité & Hydraulique, of Charleroi, a firm which seems to have disappeared as quickly as it sprang into existence.

The most amusing example of twisted language, however, which has recently come to our notice is found in a continental mining journal, in which the advertiser, desiring to call attention to the fact that he sells various ores of arsenic, publishes the following, over his name:

MINERAIS D'ARSENIC

(Mixed Pickles) de Cuivre, Fer et Manganese.

Doubtless this enterprising gentleman had heard that in Germany and elsewhere the arsenite of copper was commonly called mispickel, and his efforts should be rewarded with business success.

The real importance of the subject is seen in the numerous absurd blunders which appear in circulars, catalogues, and advertisements which are prepared by those who are not natives of the country in which business is sought, the waste of money in such mistaken methods being quite material. In these days of international trade and engineering it is most desirable that customers should be addressed in their own language, but not in such broken and distorted imitations as to make the advertisers the laughing stock of the people they desire to impress.

* * *

The advent of engineering methods and appliances into modern life has brought with it not only comforts and conveniences, but also dangers and risks against which proper protection is not always made.

Boilers are now operated under pressures far higher than were intended when the existing inspection laws were enacted, while speeds and methods of connection have been materially modified, without corresponding modification in the methods of protection. Similar facts exist in connection with the manufacture and storage of explosives, with details of building construction, with the position and operation of machinery liable to produce dangerous vibrations, and with numerous installations of power, lighting, and other industrial operations.

Under these conditions we endorse most heartily the recommendation of the president of the Franklin Institute, Mr. John Birkinbine, as to the desirability of investigating the whole subject, both in respect of existing legislation and its imperfect enforcement, and with regard to the desirability of new laws and regulations.

It is to be hoped that such investigation as may be originated by the Franklin Institute will meet with the support of the community at large, not only in America, but on both sides of the Atlantic.

REVIEW OF THE BRITISH PRESS

Electricity in the Nineteenth Century.

MR. CHARLES HAWKSLEY, in his presidential address to the Institution of Civil Engineers, takes a general retrospect of the advance made during the nineteenth century in civil engineering, which, under the far-reaching definition of the Institution, includes all branches of engineering. He considers the several divisions in order, but in this place there will only be room for some of his remarks on the subject of electricity.

"At the commencement of the nineteenth century our knowledge of electricity was practically confined to lightning conductors, invented by Benjamin Franklin in 1752, and his various other experiments and observations, and to the pile or battery discovered by Volta in 1799, following on the work of Galvani begun in 1786. After the invention of this battery the progress of electric science was extremely rapid. By its agency Nicholson and Carlisle in 1800 succeeded in decomposing water. In 1802 Sir Humphrey Davy showed the electric arc in the Royal Institution, and in 1807 he laid the foundation of electro-chemical work by decomposing potash and soda. The first great practical application of electrical science was undoubtedly the telegraph, which was the outcome of many years of persevering effort on the part of inventors and scientific investigators," being placed on a commercial basis by Cooke and Wheatstone in England and by Morse in the United States before the middle of the century, and at the present time the length of land lines in Great Britain and Ireland alone is 33,000 miles, and in the whole world about 770,000 miles.

"The first submarine cable was laid between Dover and Calais in 1851 by Crampton, following up the idea worked out by the brothers Brett, and between England and Ireland in 1853 by Mr. (afterwards Sir Charles) Bright, who also laid the first Atlantic cable in 1858. Although it was not until the above-mentioned dates that communication with distant parts of the world was achieved, there are now 1,769 submarine cables, having a total length of 189,000 nautical miles. Of these 1,349 cables of 20,000 nautical miles are under various Government administrations, and 420 cables of 169,000 nautical miles are owned by companies, nearly all of which are incorporated in Great Britain."

The latest development of electrical means of transmitting messages is wireless or space telegraphy, which has recently been brought to practical success in the hands of Marconi and other workers, and is found particularly useful in communicating with ships at sea.

The invention of the telephone, like that of the telegraph, was the outcome of many researches and experiments, but it was Bell's fortune to produce the successful commercial instrument in 1876, since which time the use of the telephone has grown with extraordinary rapidity, particularly in America and in some parts of the European Continent.

The discovery of the means of generating electricity from mechanical power constitutes the keynote of all the electrical work of the latter half of the nineteenth century. Michael Faraday, when studying the relations between electric currents and magnets in 1831, made the exceedingly important observation that an electric current would be induced in a wire moved in a magnetic field. This discovery contained the fundamental principle of magneto-electric induction, and is perhaps the invention of all others which has been of the greatest service to electrical science, for it forms the basis of the dynamo-electric machinery which has made the generation of electric currents economically possible.

The modern period of electricity may be said to date from the Paris Exhibition of 1881. Before that time the beginnings of

arc and incandescent lighting had been made, but the commercial history of these branches of electrical engineering has been made very largely in the past twenty years.

"The use of electricity for lighting was soon followed by its application to numerous other purposes, the most notable of which was motive power. At the present time electric motors are not only largely employed on tramways and electric railways, but they are rapidly taking the place of steam, gas, hydraulic and pneumatic machines for actuating machinery such as cranes, workshop tools, riveting appliances and lifts. The great opening for the utilization of electricity is evidenced by the formation of companies for the supply of electric energy in bulk in various parts of the United Kingdom. With energy generated on a large scale where coal is easily obtainable and thence conveyed to and distributed in cities and manufacturing areas, the electrical industry will be enabled to compete on a more favourable footing than is now the case with those countries endowed by nature with a plentiful supply of water power."

But perhaps the most remarkable advance made in the closing years of the nineteenth century has been in the application of water power to the generation of electrical energy, notably in countries, such as Switzerland and the United States, which are blessed with an abundant water supply. The colossal plant at Niagara is but one of many centers whence current is radiated in all directions to be utilized in lighting, transportation, and all kinds of manufacturing industry.

Even without any new and radical discoveries, the development of what we already possess affords ample scope for the efforts of our electrical engineers in the new century; but who can say that invention will not produce new wonders which will make even the great advance of the nineteenth century appear relatively insignificant?

The Future of the Steam Turbine.

EVER since the time of Watt steam engineers have been endeavoring to design some form of rotary engine which should do away with the disadvantages of the reciprocating motion of the cylinder engine, but it is only recently that the true principle of such engines has been applied. The steam wheel of Branca, and its predecessor, the oelopile of Hero, were laughed at as toys until more serious study has shown that in the modified forms of steam turbines they may be made highly efficient and satisfactory rotary engines.

From a paper on the future of the steam turbine, by Mr. W. E. Warrilow, in a recent issue of the *Electrical Review*, some interesting facts about the advantages of the steam turbine may be gathered.

Possessing but one rotating part and requiring no special foundation, it embodies all that could be desired for coupling to any type of dynamo for direct or alternating current. The improvements effected in its construction and its employment in a large number of electricity works in this or other countries should indicate that it is destined to fill a prominent place in the generating stations of the immediate future. Unlike the early undertakings, the schemes which are now planned demand units having capacities running into thousands of kilowatts, instead of hundreds, so that the class of engine which the turbine represents has every opportunity of appearing to the best advantage, as far as steam consumption is concerned. This question of consumption of steam in pounds per kilowatt has been a favourite one with consultants, the makers of engines being encouraged by the offer of a bonus to reduce it as much as possible. The guaranteed performance of a reciprocating engine in this respect has often given it the preference over such an engine as the turbine, though no calculation has been made as to the possibilities of either engine to get out of order, or increase its steam consumption with time.

An important feature of the steam turbine, not always considered, is the freedom from great or sudden angular variations in speed. This defect in reciprocating engines has been noticed at length elsewhere in these columns, and it is one which is of constantly increasing importance. With its high rotative speed, and entire absence of reciprocating parts, it is practically impossible for any appreciable variation in speed to occur in the course of a single revolution, the speed changes necessarily extending over a number of revolutions, and being gradual in their nature, while with the use of proper-

ly proportioned governors, even these gradual variations in speed may be kept within very narrow limits.

A modern turbo plant of 1,500 kilowatt capacity will stand on a floor space of 728 square feet, and will have its own condensing plant at that. No foundations are needed for its reception, and no oil is necessary for the lubrication of the rotating parts acted upon by steam. In both these items it will be at once seen that large economies in time and material will be effected. The absence of oil in the steam especially enabling the condensed water to be returned to the boilers. The machine when delivered can be assembled on its particular portion of the engine room floor, and no vibration will take place while the plant is in motion. The appearance of the engine room will also be greatly enhanced, in that the turbo sets occupy little head room, and consequently will cut off little or no light from the windows. The small vertical space needed also does much to decrease the cost of buildings as well as the steam and exhaust piping for the turbine. Combined with these are, the little attention required both for running and maintenance, and the ease of manipulation for parallel running on account of the even turning moment.

That the early types of turbine were extravagant in steam is well known, but this fault was due to the comparative scarcity of data in the design of such engines, as well as the fact that very small units were required for electric supply purposes.

The day of the small station is, however, about to depart, so that the turbo set can appear to its best advantage under the improved conditions, and where the reciprocating engine must ultimately fail, the turbine can be looked to as a reliable substitute. Such a fact is not one to cause regret on the part of engineers; rather should they welcome the new engine as a means of deliverance from the difficulties which progression on the present lines must assuredly bring. The existing state of competition in all industries, but especially the electrical one, will no doubt keep the reciprocating engine in our midst for some years to come, though the same competition will also bring more prominently to the front the steam turbine, even to the extent of finally ousting its rival.

The Commercial Relations of Gas and Electricity.

WHEN electric lighting was first introduced, the conclusion was suddenly reached that gas works were doomed, and there was an abnormal fall in the value of gas shares which created a flurry in the stock market. As it gradually appeared that there was room for both gas and electricity, this scare subsided, and at the present time both industries are flourishing side by side, and if not always on terms of amity are at least in relations of ordinary business competition.

It is altogether possible, however, that these two important industries may be linked together by close commercial bonds, and become of great benefit to each other. In an address before the Manchester section of the Institution of Electrical Engineers, Mr. C. H. Wordingham shows how the introduction of gas power may effect this result. He says, in part:

"That gas engines driven with producer gas will in the future supplant steam in electrical generating stations, there can be little doubt. But their use will not be confined to stations of abnormal size, for their inherent advantages are very great. The consumption of fuel is but little more than half that of steam-driven plants; and the cleanliness and compactness of the system, coupled with the reduction of radiation and stand-by losses, render possible great strides in the direction of cheapening electrical energy even in very small stations.

"There is one method of supplying small towns and villages which might prove a cheap and easy solution of giving to them the advantages of electrical energy. There are few towns so small as not to have gas works. Why should not the gas company establish a producer plant, and sell the gas to a locally formed electrical company or to the local authority to use for driving electrical generators? It would not be desirable for the gas company to undertake the electrical portion of the business for themselves, partly because their staff would not have the necessary experience, and partly because they would be tempted to stifle the electrical work. On the other hand, by the suggested course, each portion of the work would be looked after by those most competent to deal with it; and it

would be to the interest of both parties to make the electrical undertaking succeed, for the gas company could make as great a rate of profit on the producer gas as on the ordinary lighting gas, while still enabling the electrical company to produce cheaply.

"In considering this matter it must not be forgotten that the preparation of producer gas for gas engines is by no means a simple matter; and if to this be added an ammonia-recovery plant, a considerable amount of skill is required on the part of those looking after the manufacture. This skill is available in gas works; and for this reason it would pay to put down recovery plants for producers working on a much smaller scale if the operations are carried on in connection with such works than if the plant were isolated. This extension of the gas company's make would not be at the expense of their existing business; for it is a matter of experience that the introduction of the electric light sets a higher standard of illumination, and actually increases the demand for gas for ordinary purposes. Hence the introduction of the electric supply would be a clear gain to the gas company."

There is little doubt that the use of gas power is more economical than steam, but it hardly seems probable that the installation of a gas producer plant demands more skill than would be required in the electric station in connection with the gas engines and electric generator, and it does seem as if the proper place for the gas producer would be in the electric station. Mr. Wordingham's proposition appears to be all right for very small towns, but for anything else we fail to see why a producer plant and gas engines might not very well replace steam boilers and engines. There is no need for the gas plant to be at the same place as the electric plant, although both might well be without the city boundaries, and thus suppress the smoke nuisance by keeping away from the sections which might be disturbed by it.

The gas engine, or rather some form of the internal combustion engine is destined to be the motor of the very near future, and this is as true of electric generating stations as it is of other power plants.

Scientific Discovery.

Sir W. H. Preece is always interesting in his public addresses, and his broad grasp of the field of pure and applied science makes his utterances especially worthy of notice. In his recent address before the Society of Arts, published in full in the *Journal* of the society, the general progress of scientific discover in the past century is dealt with, and some forecast of the future is made. That there is much in the immediate future is undoubted.

"The workers in the realm of scientific research are increasing in compound ratio. Their weapons of attack upon nature's secret storehouses are increasing at the same rate. The practical developments of these unknown principles must necessarily grow in ever widening circular waves of practical utility and increased human comfort. It is dangerous to prophesy, it is simple to forecast. It is impossible to surmise the discoveries that are to come. We only know that they will be absolutely unexpected. But we can observe the progress of existing practical applications of science, and by watching the trend of advancement, and following the motive causes of progress, guess at what is likely to be the result in the immediate future."

Sir William Preece enumerates the great scientific discoveries of the nineteenth century to be as follows:

The principle of evolution.

The atomic structure of matter.

The existence of the ether and the undulatory theory of light.

The principles of electro-magnetic induction and electrolysis.

The principle of the conservation of energy.

These he proceeds to discuss at length, showing their influence upon what we may expect to follow and supplement them.

In the course of evolution we may expect selective modification to be influenced by the mainsprings which are acting most powerfully: the struggle for power, the race for individual wealth, the pursuit of knowledge, the combat with disease, the advance in comfort of living; and these forces may be expected to act in the future as they have in the past.

The study of the atomic constitution of matter may lead to the discovery of many new elements, or possibly to the revelation of the one fundamental element, of which all others are but varied manifestations.

The existence of the ether is still inexplicable in its mechanical structure, although its reality is even more fully accepted than ever. It offers no resistance to wave motion, and in it energy is not dissipated away into heat, as in the undulations and vibrations of matter. Still no final theory of its structure has been produced, and that problem still awaits its solution in the twentieth century.

Electromagnetic induction is only beginning to unfold its possibilities. The communication of energy without the use of metallic or other material conductors is within sight, and in the form of space telegraphy has been partially realized. Electrical decomposition may be followed by recomposition, and the artificial synthesis of organic compounds become commercially and wholly possible. With all these comes the principle of the conservation of energy uniting the action of force, motion, and matter in ever changing relations, but always with an unchanging sum total.

Sir William Preece discusses in an able manner the present practical applications of energy, and this most interesting portion of his address should be perused at length. In all he shows the intensely practical uses of scientific discovery, and emphasizes the fact that the small details of our everyday life are closely bound up with the work of the engineer, the physicist, the chemist, the so-called man of pure science. In it all is seen the fundamental fact that progress in all branches of life is due to certain motive causes working on the principle of evolution; that these causes are within the reach of our observation; and that they have only to be discovered, so that, by their encouragement, we may secure, during the coming century greater and further advances in civilisation and knowledge.

The Balancing of Locomotives.

THE question of balancing engines of every sort is a matter which is receiving increasing attention, and elsewhere in these columns we have discussed the solution of the problem as applied to marine engines. In a paper recently presented before the Institution of Mechanical Engineers, Professor W. E. Dalby treats of the balancing of locomotives, dealing with the method of obtaining the magnitude and position of the balance weights for locomotives, and also examining the different ways of dealing with the reciprocating masses in coupled engines.

The method described by Professor Dalby is semi-graphical in its nature, and cannot be discussed in detail here, but some general idea of the principles involved may be given.

In a locomotive a portion of the masses are rotating about the axis of the driving wheels, another portion has a reciprocating motion, coming to rest twice in every revolution, while still another portion has a motion combined of these two. The rotating masses can be entirely counterbalanced by suitable weights, attached to the driving wheels; the reciprocating and the mixed portions may be partially so balanced. In the early history of the locomotive no balance weights were used, but about fifty years ago, as speeds and weights increased, balancing was found necessary, and at first the balance weights were made equal to the whole weight of the moving parts. Experience showed that this was too great, and, by the method of trial and error, practice gradually resulted in the adoption of weights equal to five-eighths of the moving parts for single driving wheels, and to two-thirds the weight for coupled engines.

The correct weight, as well as its position, depends upon the relative magnitude of the various forces for any particular case, and the method of Professor Dalby enables this to be determined graphically by reducing all the forces to their equivalents at crank radius, and then constructing a force polygon. The proper weight will then be that which causes the force polygon to close, in accordance with the general principles of graphical statics.

The method is shown in detail as applied to some existing engines, and the results show that the above proportions as determined by experience are very nearly those found by computation.

In many instances compound locomotives are now made with four cylinders, two being outside and two inside, and with such engines the Yarrow-Schlick-Tweedy system of unequal crank angles, as applied to marine engines, is applicable, and this has been tried in some cases in Germany.

The principal consequences of imperfect balancing, apart from vibration, are the effects upon the track and upon bridges and

other structures over which the engine may be run. The so-called "hammer blow" results from too little or too much weight in the counterbalances, and it has been maintained that light rails have been broken by heavy engines, the breaks appearing at points distant from each other by the circumference of the driving wheels.

In coupled engines the effects of improper distribution of the balance weights between the two driving wheels appear in the wear upon the coupling rods, crank pins, and brasses, a fact which has been well known to practical locomotive engineers for a long time.

The general tendency in railway practice is to use somewhat less balance weights than formerly, the guide in this respect being the observed effect upon the wear of tyres. The whole tendency at present is rather to make the balancing a part of the distribution of the necessary weights, and to use as little additional weight as possible.

It is evident that in a reciprocating engine perfect counterbalancing is impossible, and that the best which can be done is to effect a compromise between conflicting conditions. The true solution of the problem is to replace the reciprocating motor with one entirely rotary in its motion, and in this respect the great advantage of the electric motor is apparent. The practical limitation to high speed with steam locomotives is found in the strength of the reciprocating parts, the breakage of connecting rods and coupling rods being the weak point. With the electric motor the limit is found in the resistance of the rotating parts to the action of centrifugal force, and this is a much higher limit than that for the reciprocating parts.

Technical Education in England.

In a recent editorial in *Engineering* the question of the importance of making technical education the direct means of developing industrial progress was discussed in connection with an account of the "Central Stelle" established and maintained by an association of manufacturers in Germany. This especial institution had for its object the investigation of methods of manufacturing explosives, but there are other similar ones in other lines of work. There are no precisely similar institutions in England, nor indeed anywhere else, although we believe there is some association of methods and information among the chemical laboratories of the iron manufacturers in the United States. The latest educational endowment of Mr. Andrew Carnegie is intended to found such a general institution for the advanced research in Washington, in connection with the various government collections and institutions, and altogether there seems to be a general awakening to the close connection between advanced technical education and material prosperity.

It is difficult to say where the limitations of this question are to be found. Some maintain that it is impossible to expect manufacturing and industrial establishments to permit the details of their methods to be made public or to get into the hands of possible rivals, while in other quarters it is believed that publicity within reasonable limits is for the benefit of all concerned.

This question was agitated to a limited extent at the recent meeting of the British Association, and from the criticisms there made of the Board of Education it is clear that many are of the opinion that there is room for improvement in educational methods in Great Britain, especially in connection with industrial development.

The true place for the foundation of technical training is in the primary schools, and it is in these that there is much room for improvement, not so much in the matter as in the manner, and in the development of correct habits of thought. With such a foundation, the development of special training centres can properly follow; without it, they would be worse than useless.

Electric Traction on the Underground.

The electric operation of the "Inner Circle" underground railway in London will soon be an accomplished fact, owing to the recent decision in favor of the system variously known as the Yerkes, American or direct-current, and it may be of interest to review the proceedings before the arbitrators which led to the decision in question, as reported in *Engineering*.

The Inner Circle is worked by two companies, the Metropolitan and the Metropolitan District, the latter called the "District" for short, and the Great Western Railway also runs some trains over parts of the sys-

tem, which it is also purposed to connect with other surface and long distance lines.

The various proposals for "electrifying" the Underground narrowed down to two, one plan being advocated by the District company, the other championed by the Metropolitan. The former plan is to generate high-voltage three-phase current at the power house, convert to 500- or 600-volt direct current at rotary-converter sub-stations placed at convenient intervals along the line, and collect this current from a third rail for use in the car motors.

The Metropolitan scheme is to generate high-tension polyphase current as in the other plan, but then to transform it at the stations on the road down to 3,000 volts and distribute it along the line by overhead wires, whence it will be collected by trolleys and delivered to polyphase motors on the cars.

The former system is the one used and about to be used on various roads with heavy traffic in American cities, and the direct current part, which immediately concerns the working of the line, is universally employed on American and British electric railways, as well as on most Continental ones. The polyphase in the form proposed by the Ganz Company, is most closely approximated by an experimental road at Budapest and the recently built Sondrio-Lecco railway in Italy.

It is obvious that only one system can be used on the Inner Circle, and as the conflicting interests would come to no agreement, the matter was submitted to an arbitration committee, on which Mr. Horace F. Parshall represented the District company, Mr. Thomas Parker the Metropolitan, while the Hon. Alfred Lyttelton was appointed umpire by the Board of Trade. The principal counsel for the District company was Mr. Fletcher Moulton, while Mr. C. A. Cripps acted in a similar capacity for the Metropolitan.

In opening the case for his company, Mr. Moulton stated that the District did not only own a portion of the Circle, but also a considerable section beyond it. In the Inner Circle the District owns 4 miles; there is about 1 mile which is owned jointly; the Metropolitan owning about 7 miles. The outlying connections are partly feeders and partly independent traffic lines and extend over about 25 miles. The traffic on all the lines is naturally very dense, and especially so on the Inner Circle, where there are 220 trains a day making the whole circuit and about twice that number running over a portion of the underground road.

The conversion of this system from steam to electric operation is a serious matter, involving a financial risk which depends on the probable traffic to be secured by the change. But there is really no electrical risk if the plan advocated by the District Company be followed. In America there are about 21,000 miles of electric lines operated on this system, some of them light tramway lines, but some of them easily comparable with the Inner Circle in the frequency and density of their traffic. All this electrification of railways has been accomplished within the last 15 years. Large sums have been spent on experiments. Various systems have been suggested and tried and laid aside; numbers of devices have been worked on paper and let alone. There has been, however, a steady approach to one definite type of electric traction, which has been found to answer all requirements. This type the District proposed to use, and in any project such as the one under discussion, two main considerations must not be lost sight of: First, the system must be a safe one; and, second, there must be a certainty of uninterrupted traffic.

In regard to the first consideration, by the District system the dangerous high pressures were confined to insulated, buried conductors leading from the main station to the sub-stations; and concerning the second, the vast amount of experience gained in America and elsewhere was an assurance of continuous operation.

Mr. Yerkes testified that he had been in command of between 500 and 600 miles of street railways, all of which he, together with others, had either built or changed and improved; part of these were tramways, part elevated roads, part low-level, and part cable roads, all running through a closely built up city, and with trains traveling at a three-quarter minute headway. The whole of the Chicago lines transformed or built by Mr. Yerkes carry about 480,000 passengers a day. All these lines are on the direct-current system, which has been doing good service year after year. The usual

working pressure is 500 volts, and there has never been a death due to electricity on any of these lines.

Mr. E. W. Rice, third vice-president of the General Electric Co., stated that it does not make any difference to his company whether they supply polyphase or direct current machinery, provided one will do the work as well as the other. He said that three-phase generation and transmission at high pressures, with ultimate conversion into direct current of 500 or 600 volts for use on the line, was the system now practically universally adopted in large traction undertakings; he did not know of, and did not believe there was any better one for driving tramways and elevated roads as well as tunnel roads where the service requires frequent stops and high acceleration at frequent intervals.

Mr. Swinburne confirmed in every point the evidence given by Mr. Rice, and Mr. Chapman and Mr. Philip Dawson, both engineers of great experience in traction work, were equally emphatic in favor of the direct-current system, while Mr. George Estall, engineer and locomotive superintendent of the District company, deprecated the use of overhead wires on the Underground whatever be the system of traction resorted to.

Mr. Cripps opened on behalf of the Metropolitan Company, which, he said, might claim to be the predominant partner, as it had a greater interest than the District both in the Inner Circle and in the interpolated, or outside traffic, its outlying system of extensions and branches amounting to more than 50 miles, without counting the line to Quainton Road. His clients were actuated by but one desire, which was to get the best possible system for the Inner Circle and their outside roads. He pointed out that the alternating-current installation would be much cheaper than the direct-current one, owing to the absence of rotary converters in the former; besides this, there would be 13 per cent. more power required by the direct current system than by the alternating, owing principally to more leakage from the line in the former. This greater power requirement would increase the coal consumption and the operating expenses,, the latter being also greater with the direct current, owing to the necessary attendance on the rotary converters.

In regard to safety, Mr. Cripps made the point that the overhead wires of the alternating system were inaccessible and protected by safety devices, while the live third rail of the direct-current system, even though carrying a lower pressure, was a constant risk to workmen and the public.

Mr. O. T. Blathy, manager of the Ganz Company, testified concerning the technical side of the alternating project, and endeavored to show that all the electrical difficulties had been overcome and that there could be no question about the satisfactory and continuous operation of his company's system on the Inner Circle. The experience on which he based his evidence was largely gained on the experimental line at Budapest and on the Sondrio-Lecco railway, though polyphase traction, with important differences in detail, has been successfully applied to other roads, notably that between Burgdorf and Thun, and the one up the Jungfrau, in Switzerland.

Mr. Gisbert Kapp, Mr. Koloman de Kando, Prof. J. A. Ewing, Major Philip Carew, Mr. Ernest Talbot and Prof. Sylvanus P. Thompson all testified in favor of the alternating system, but some of this testimony was considerably shaken on cross-examination by Mr. Moulton and Mr. Parshall.

Summing up, it may be said that the points in favor of the Ganz, or alternating project are a possible economy in first cost of installation and operating expenses, and, perhaps, a better adaptability to outside connecting railways, if these extend to any distance. The great, and probably the determining objection to it is its experimental nature, particularly for such a road as the Inner Circle, the last place in the world in which to try experiments.

On the other hand, the direct-current system is admitted by all parties to be perfectly feasible for the Underground, and has stood the test of years of experience on all kinds of roads, and it is claimed by its advocates, that, taking everything into consideration, including possible interruptions and breakdowns, it will be decidedly the better, even from a purely economical standpoint, for such a line as the Inner Circle.

It is not surprising, therefore, that the decision of the arbitration committee has been in favor of the direct-current system.

The International Bureau of Weights and Measures.

THE great importance of the maintenance of correct standards for measurements of length, volume, and weight has been realized for a long time, and since such dimensions enter into many commercial transactions to almost as great an extent as the money consideration, the establishment of such standards has rightly been considered as a function of government. Indeed the question of standards of measurement have advanced somewhat further than monetary standards, since it has reached an international stage, while international money is yet to be attained.

A recent series of papers by M. C. E. Guillaume, appearing in the *Bulletin de la Société d'Encouragement pour l'Industrie Nationale*, gives an excellent account of the remarkable work of precision which is being conducted under the auspices of the International Bureau of Weights and Measures, at Breteuil, near Paris, with especial reference to the maintenance and reproduction of metric standards.

The metric system has now completed its first century of existence, and its use has extended into many countries, having been especially welcomed in those lands in which confusion existed because of uncertainty, unreliability, and multiplicity of older units. Since the rather sentimental idea of having the metre represent a definite portion of the circumference of the earth has been abandoned, it has been found advisable to select a standard more easy of comparison, and hence the distance between two marks on a bar of metal is accepted. This distance is really a certain portion of the double toise used by Delambre and Méchain in their measurement of the arc of the meridian between Dunkirk and Barcelona, and has been established by order of law, a much simpler and more accurate method than that of terrestrial measurement. The prototype of the metric system, therefore, is the *Mètre des Archives*, with its two companions the *Mètre du Conservatoire* and the *Mètre de l'Observatoire*. From these the measure of weight is also supposed to have originated, being intended to be the weight of one cubic decimetre of water, but the variations which have been found to exist in this determination have caused the actual standard of weight to be that of a certain metallic weight legally designated as the standard kilogramme.

The gradual advances which have been made in methods and instruments of comparison, together with the higher degree of precision required, has made it necessary that some provision should be made for this work, and as a result of the work of scientific men in various parts of the world the International Bureau has been established in Paris. This bureau was the direct result of the International Metric Commission, which, dating from 1870, has had in hand the solution of a number of the important problems of metrology.

The work of this commission is far too voluminous to be discussed fully here. First of all came the exhaustive study of the *mètre des archives* in order that its actual length might be determined, and that accurate reproductions might be made, thus permitting the establishment of an international metre. To this is added the production of standards of weight and the practical solution of all the problems connected with these determinations.

M. Guillaume gives an interesting account of the buildings and equipment at Breteuil, showing the excellent manner in which it is adapted for the work. The principal instruments naturally are the comparators, by Brunner, by the *Société Genevoise*, by Bariquand & Marre, and by Starke & Kammerer. In connection with these are balances, thermometers, normal barometers, and the innumerable appliances and auxiliary apparatus.

Since the question of expansion and con-

traction of the metals used for standards of length is a most important element in the comparisons, much attention has been given to thermometry, and many of the researches in this direction have been carried under the immediate direction of M. Guillaume himself. This work forms in itself an important study in thermometry, and includes not only the question of graduations, but also the expansion of various kinds of glass, the changes in the zero point, the calibration of the tube, the influence of external pressure, etc. With these researches is also included a study of the air thermometer, and of gas thermometers, and the results, being plotted in the form of curves, show very clearly the variations in the different constructions. At the Bureau there have also been made studies of devices for measuring very low temperatures, thermometers using toluêne having been shown to indicate temperatures down to —75° C. within one-twentieth of a degree. Pyrometers for the measurement of high temperatures, have also been investigated.

The two normal barometers of the Bureau are illustrated and described in the paper. These are so constructed as to permit the height of the mercury column to be measured by means of observing telescopes reading a cathetometer scale, and every provision is made for the determination and correction of instrumental errors. With these instruments the atmospheric pressure can be determined within 1/100 of a millimetre of mercury.

The comparators are arranged for various kinds of work. Thus the Brunner instrument is arranged for the rapid and accurate comparison of standards of 1 metre in length, the bar to be examined being placed on a carriage together with the standard bar, and brought beneath the wires of two micrometer microscopes. The comparator constructed by the *Société Genevoise* is especially designed for the study of expansion of metals, being arranged with a trough of water which may be maintained at any desired temperature. It was with this instrument that M. Guillaume conducted the important studies of the nickel-steel alloys which resulted in the remarkable discovery of the very low coefficient of expansion of the 36 per cent. nickel alloy. Other comparators are used for the calibration of the rods used for the measurement of geodetic base lines, these rods usually being four metres in length, and hence being beyond the capacity of the usual instruments.

While the fact is generally known that the International Bureau of Weights and Measures is doing good work in its own especial field, it requires the perusal of some such detailed description as that of M. Guillaume to enable a fair idea of the high character of its investigations to be formed. The whole description shows how the modern physical laboratory forms a connecting link, not only between the man of pure science and the operative mechanic, but also how it enables the accuracy and precision of the trained investigator to be placed at the disposal of the practising engineer

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Military Automobiles.

In view of the general interest in automobile vehicles, and their applications not only to pleasure carriages, but to many industrial purposes, the paper of Captain Douhet, recently presented before the Italian Electrotechnical Society is of interest. Captain Douhet treats of the automobile from a military point of view, and aims to show the conditions under which self-propelled vehicles may be expected to render service in military operations.

The relation of engineering to warfare is very clearly indicated by the opening statement in Captain Douhet's paper. As soon as any important invention is made among civilized nations, the first question is: How can it be adapted to the purposes of warfare? It is most natural that this query should be applied to the motor vehicle, especially since the difficulties experienced with horses have continually increased in recent years. Speed of movement, handling of supplies, command of artillery, all these, and many other vital points are intimately connected with the horse or his substitute, and notwithstanding the noble work which the horse has done in the past, his mechanical successor will be eagerly welcomed so soon as it proves itself equal to the many severe duties which are demanded.

While the present state of the art of automobilism is such that the requirements for military service are by no means fulfilled, yet it is only by a review of the present state that the line of work for the immediate

future can be indicated. After examining the principal systems now in use, viz: steam, gasoline, and electric, the author passes to the actual conditions in warfare in which a self-propelled vehicle might possibly be used. The movements of an army may be analyzed in detail, and the possibilities of employing automobiles thus examined critically. In the mobilization of an arm upon the declaration of war the railways naturally play the principal part, and for this the automobile offers no advantages. When the troops are mobilized the army is put in movement as a whole. For the large units motor vehicles are evidently unsuited, but it is quite possible that certain small units might well follow the cavalry by the use of automobiles. Vehicles for this purpose would keep to the main highways, and would resemble in general features the motor omnibus, being really intended to be an accelerated substitute for marching. So far as the field artillery is concerned it does not appear feasible to use mechanical propulsion, and it would probably be better to provide more and better horses for this arm, a plan which is made possible by the use of automobiles elsewhere. For the transmission of intelligence and of orders the field telegraph naturally holds the first place, and the bicycle has shown itself to be a useful second. It is probable, however, that a gasoline vehicle would be valuable for this service where the roads were not choked.

In considering the possibilities of the automobile on the field of battle it must be emphasized that in future engagements the field will probably be very extended. An army composed of three army corps and one division of cavalry fills about 300 complete railway trains. At 24 trains per day this means 13 to 15 days for transport over a distance of say 100 kilometres, while on an ordinary road this distance could be marched in four days. When it comes to manœuvres on the field in the face of the enemy it must be obvious that automobiles are unsuited. Even assuming that the vehicles carried 50 men each, it would require 240 automobiles in constant readiness for a detachment of two brigades of infantry; 12,000 men. We come now to the movement of *matériel*, including the great mass of supplies which form the life blood of an army, and on which the failure of circulation means disaster. This service means the transport of supplies from the surrounding country, and from bases, to the army, the distribution to the main units and subordinate portions, and the removal of debris to the rear. Some idea of the magnitude of this service is seen when it is understood that for a force consisting of three army corps, and one division of cavalry, a total of 100,000 men, there are now required about 5,000 wagons, and 15,000 horses; and allowing 1 kilogramme per man and 5 kilogrammes per horse, there will be 200 tons of supplies to be handled daily. It is in this service that motor vehicles may well find applications, if they can be made equal to its requirements.

Bearing in mind the fact that the supplies cannot always be transported over roads, or that these latter will usually be in good condition, the essentials of vehicles for the service may be considered.

First of all comes the condition of stability. The service must be maintained; it must not be crippled by breakdowns; it must include ample strength in the vehicles and ample propelling power of a reliable nature.

Leaving for the present the precise construction to be employed, we consider the capacity and dimensions. At the present time the maximum weight is limited by the necessities of horse traction to about 5 tons. A larger capacity is desirable, but the limitations of the roadway must be taken into account, so that it appears that 10 to 12 tons is about the best capacity, with the provision of a limited number of vehicles of 20 tons for service in the transport of siege *matériel*. The length of the convoy is determined by the length of the vehicles, plus that of the motors or propelling power, plus the necessary space between the vehicles. It is therefore desirable to keep the vehicles short and the space between them a minimum. The ordinary speed of a convoy is about 4 kilometres per hour, but with motor vehicles this may be materially increased. It is necessary that the convoy should preserve its unity, and be at all times under control as a whole, and with these limitations the practicable speed may be from 8 to 12 kilometres per hour. With the ordinary horse haulage the usual distance traversed daily is about 40 kilometres, and in exceptional instances

it may attain 60 kilometres. The principal limitation is that due to the horses, and hence the advantage in this respect, of substituting mechanically propelled vehicles. With automobiles the length of the daily journey depends the human element mainly, the machines being capable of almost indefinite endurance, if maintained in good working order.

The question of the fuel consumed by the motor vehicles is necessarily an important one, but it must be remembered that horses also require supplies to be transported for them, and that horses must be fed when idle, while the combustion of fuel ceases when the automobile is stopped. Assuming the relation of useful load to the total load as 0.66 per cent., the remainder after the load of fuel is subtracted will be the useful load, and knowing the fuel consumption per unit of distance traversed, it is a simple matter to compute the distance at which the total capacity of the vehicle will be required for its own supplies.

When all these and similar conditions are taken into account it will be seen that no one of the existing types of automobiles is capable of fulfilling them. The electric vehicle carries far too little useful load to be available. The gasoline-motor vehicle, as at present developed, is not suitable for transporting heavy loads, and requires too much attention to prevent breakdowns. The light steam automobile presents both of the difficulties of the preceding, but in a less degree. To these must be added the necessity for a large supply of water, and this, added to the fuel, liquid or solid, limits its radius of action. Steam traction engines, which have been advocated for hauling supply trains can be shown to give no greater speed or capacity than their equivalent in horses, and hence are out of the question.

That the problem will remain unsolved is by no means to be admitted. Indeed Captain Douhet himself offers a solution, namely to employ electrically propelled vehicles, taking their current, not from storage batteries carried by each vehicle, but from generators driven by internal combustion motors, and carried on vehicles especially designed for the purpose. The automobiles would be connected to the generators by cable, a series forming a convoy train. We have not space here to go into the details of the system, but we commend the whole treatment of the subject, which we have outlined above, to those engineers, who, while attacking the broad problem of military automobiles, may not have had all the difficult conditions fully and systematically placed before them.

Modern French Shipbuilding.

In the general extension of shipbuilding among the great commercial and manufacturing nations France has not been behindhand, as may be seen from a recent article in *Le Génie Civil* by M. A. Dumas, describing the latest vessels of the Compagnie Générale Transatlantique, "La Lorraine" and "La Savoie." These fine ships, which are, with minor unimportant differences, identical in dimensions and construction, are 177.5 metres in length (582.35 feet), and 18.28 metres beam (59.97), with a displacement of 15,410 tons and an indicated power of 22,000 h. p.

While these figures are not so great as those of some of the mammoth vessels of other countries, such as the Oceanic, the Deutschland, and others, yet they represent in other respects important advances in the art of shipbuilding for high-class passenger service.

The ocean record must lie with the largest ships, and these are of necessity barred from the Havre-New York route because of the limitations upon the dimensions for entrance at the French port, or for docking with the facilities there available. Under these limitations, therefore, it was impracticable to attempt to rival the dimensions of the largest ships of other lines, and consequently it was determined to devote attention to those even more essential elements, comfort, safety, beauty of finish and decoration, and such speed as should satisfy every personal and commercial demand.

In the account of these new French vessels given in the above mentioned article, the various details of construction and equipment are given in much detail, and some engineering features are of interest.

The total displacement, as above stated, is 15,410 tons, but of this great weight only 27 per cent. is variable load, the remaining 73 per cent. being fixed load, including hull, engines, boilers, etc. Of the variable load of 4,150 tons, fully 3,000 tons

is that of the coal, leaving only 1,150 tons or about 7.5 per cent. of the total displacement for passengers and merchandise. A large part of this great increase in proportion of fixed load over earlier vessels is due to the demand for high speed. Thus in the case of the Champagne the variable load is 1,430 tons for a total displacement of 10,010 tons, or about 14 per cent. In increasing the speed from 17 to 20 knots, an increase of about 17.6 per cent. in speed, the useful carrying capacity has therefore been reduced about one-half. The total number of passengers of all classes which can be carried on the Savoie is 1,074, while on the Champagne it is 1,209, so that the large vessel actually carries a smaller paying load. With the exception of the *cabines de luxe*, however, the rates are the same for both vessels, but the apparent loss in revenue for the new vessels is fully made up in the higher economy of the more modern engines and machinery. This fact alone is a striking tribute to the direct relation of engineering to personal comfort and convenience, since passengers are carried across the Atlantic in a vessel far more luxurious and comfortable in its appointments than formerly at more than 17 per cent. higher speed, for the same price because engineers have succeeded in making their engines consume a little less fuel.

There is no remarkable innovation in motive power by which superior economy has been attained, this resulting simply from the general advance in design and construction which has taken place in the fifteen years intervening between the construction of the two vessels.

The Savoie is equipped with Scotch type cylindrical boilers, operating under forced draught, with a pressure of 170 pounds per square inch. The auxiliary machinery is supplied with steam from two boilers of the Belleville type, and much of the auxiliary work is performed electrically, the dynamos being driven by de Laval steam turbines. The main engines are triple expansion four-cylinder machines, there being two low-pressure cylinders, this giving constructive advantages besides permitting the employment of the Yarrow-Schlick-Tweedy system of balancing. Each engine is capable of developing 12,000 h. p., but in actual service about 9,000 h. p. is produced, or 18,000 h. p. for the pair. Independent condensers are used, and the piping is so arranged that any cylinder can be thrown out of service in case of necessity, and the three remaining cylinders run without it. In this as in every other mechanical detail, the best care and thought has been given to safety and to provision for every possible emergency.

This is not the place to descirbe the beauty of decoration and furnishing of the new vessels, except to say that the high standard of French taste has been well maintained.

The vessels were designed from the plans of the engineer-in-chief of the company, M. Daymard, and constructed at the yards of the company at Penhoët, Saint-Nazaire.

The Influence of Temperature on the Strength of Bronze.

About a year ago there was published by the *Verein deutscher Ingenieure* a report of important investigations upon the diminution of the strength of bronze by heat, these having been made by Professor Bach upon specimens furnished by the Imperial shipyards at Kiel.

We now have a further account of these researches, in a paper by Professor Bach in the *Zeitschrift des Vereines deutscher Ingenieure*, the investigations being upon a bronze of a somewhat different composition, furnished by Messrs. Schaeffer & Budenberg, of Magdeburg-Buckau. The bronze tested and reported upon in the present paper contained 87 parts copper, 8.7 tin, and 4.3 zinc, and at the atmospheric temperature of about 20 ° C. (68° F.) the resistance under tensile test was 2,431 kilogrammes per square centimetre (about 34,600 pounds per square inch), with an elongation of 15.2 per cent. and a reduction in cross-section of 17.4 per cent.

The apparatus in which the tests were made consisted of a vertical cylinder open at the top and provided with a bottom through which the lower head of the vertical testing machine passed and was secured. This cylinder was surrounded by a jacket of sheet metal provided with a circle of gas blowpipes, so that the heat was directed against the inner cylinder and the hot gases were kept in contact with it by the jacket. The inner cylinder was filled with palmine,

having a boiling point higher than the upper limit of the test, and the whole was carried upon the lower head of the testing machine. The test piece was attached to the lower head, and an extension piece reached down from the upper head of the machine to connect with the upper end of the test piece. The latter was therefore completely immersed in the palmine, and the entire apparatus moved with the lower head of the machine, the slight motion being insufficient to affect the immersion of the test piece. In this way it was possible to maintain any desired temperature, within the experimental limits, and to observe the conditions of test very precisely.

It has been generally understood that copper and its alloys lose strength with increasing temperature, and indeed the experiments of the Franklin Institute about fifty years ago made this fact apparent. The tests of Professor Bach, however, show also the influence of heat upon extension and upon the reduction of cross-section, besides furnishing much more accurate quantitative data than was possible in the case of the earlier researches.

The data and results of the tests are tabulated very fully in the original paper, curves also being plotted to show the relations of temperature and resistance, but for these the reader must be referred to the original. The general results are as follows: Up to 200° C. (about 392° F.) the tensile strength was affected but little, the tests showing the resistance at 200° C. to be about 96 per cent. of the original value. Beyond 200° C., however, there is a rapid falling off in strength. At 300° C. (572° F.) the strength fell to 65 per cent. of the original value; at 400° C. (752° F.) it was but 45 per cent.; and at 500° C. (932° F.) the strength was but 28 per cent. of that at ordinary atmospheric temperatures.

These results are not greatly different from those previously obtained. They are slightly higher, but this is probably due to the somewhat smaller percentage of copper present in the alloy.

In regard to extension the results, while peculiar, confirm those previously obtained by Professor Bach in connection with the tests of pieces from Kiel. The ductility at 100° C. is slightly greater than at atmospheric temperatures, but with the increase of heat it fell rapidly, being but 39 per cent. at 300° C., and practically disappearing at 400° C., a similar change in reduction of cross-section appearing. Thus it is seen that not only does the strength of bronze diminish rapidly at temperatures above 200° C. (392° F.) but the ductility, one of the most important properties of copper alloys, falls off still more rapidly.

To quote the words of Professor Bach: The material tested, although an excellent bronze, as understood under ordinary conditions, is entirely unsuited for pipes or similar work for high or even moderately superheated steam.

It has generally been thought that the failures of copper and bronze pipes under modern steam pressures was mainly due to the weakness of the brazed seams, and numerous methods have been made to provide seamless copper pipes of large diameter for marine and similar service. It has even been attempted to produce pipes by processes of electro-deposition, with the view of obtaining an entire freedom from weakness of seams or brazing, but according to these most reliable experiments, the copper bronze itself loses so much of its strength and ductility as to be unfit for high pressure and temperatures. Since the use of superheated steam at pressures above 200 pounds is becoming general it is evident that copper alloys must be replaced by more reliable materials.

The Speed Regulation of Prime Movers.

One of the problems in connection with the conversion of reciprocating into rotary motion, as in the case of the steam engine, has been the control of the speed. With the early pumping engines of Watt and his predecessors this was a matter of small moment, so long as the water did not gain on the pumps or the engine dash itself to pieces against its buffers. The introduction of the centrifugal governor naturally accompanied the development of the rotatory engine, and with the application of steam power to spinning factories, flour mills, and other industries involving comparatively uniform rotary speeds, various improvements in speed regulating devices were evolved.

A new interest was directed to this question as the modern industry of electricity

became of importance, and when every variation in engine speed showed in the flickering of the lights, it was evident that closer regulation must be maintained.

An interesting analysis of this problem, so far as electrical generating sets is concerned, is found in a paper presented before the *Verband deutscher Elektrotechniker* by Dr. Rudolf Franke, and published in a recent issue of the *Elektrotechnische Zeitschrift*, while the discussion of a special detail of the regulating mechanism, i. e., the fly wheel, is made by Herr Alexander Rothert in the *Zeitschrift des Vereines deutscher Ingenieure;* the two papers making a valuable contribution to this important branch of steam and electrical engineering.

Until recently the practice among steam engineers has been to express the variations in speed in the percentage of revolutions permitted from the rated speed. Thus an engine rated to run at 100 revolutions per minute was said to vary not more than 2 per cent. above or below its rating if the speed did not exceed 102, nor fall below 98 revolutions per minute; this being considered an excellent performance. It is evident, however, that an engine might fulfil these conditions and yet fluctuate very materially in angular velocity during a single revolution. Manifestly such a variation is undesirable for electrical machinery, and hence it has become necessary to study the regulation of engine speeds from an entirely different standpoint than formerly.

In order to examine this question intelligently Dr. Franke has devoted his attention to the construction of devices for recording the fluctuations in engine velocity, and having accomplished this end he proceeds to discuss the results obtained by their use.

When a reciprocating engine maintains a uniform number of revolutions per minute, the angular variations appear in a periodical form. It is therefore possible to consider the motion of the engine shaft as composed of two elements, one the continuous uniform number of revolutions per unit of time and the other the vibratory variations from uniformity per revolution or multiple thereof. It is these vibratory variations which it is desired to record and study, with a view to their modification or elimination.

If we can imagine the actual velocities to be taken as ordinates and the intervals of time as abcissas we shall obtain a line composed of short alternate waves representing the angular variations, the whole line also undulating in accordance with the variations in the number of revolutions per minute. The latter undulations represent the variations in load under the corrective action of the governor, and with modern governors they can be kept within very close limits. The periodical variations are entirely independent of the governor and are not produced by the changes in loading, but must be sought for elsewhere. Their origin is found partly in the variations in impulses upon the crank and partly upon the elastic periodicity of the members which communicate the power to the flywheel, including the torsion of the shaft, the elasticity of the steam itself, and similar influences.

Dr. Franke describes a number of devices which may be employed to record automatically the angular variations, some of them being very ingenious. Those which may be called strictly mechanical depend for their action upon a differential connection between the engine shaft and a heavy rotating fly wheel, the engine shaft gaining or losing upon the fly-wheel which it drives through the differential connection. This gaining and losing can readily be transferred to a recording drum, showing the vibrations in angular velocity. An optical device is also described, in which a beam of light is thrown upon a perforated revolving disk driven by the engine shaft and possessing all its variations in speed. After passing through the perforations in the rotating disk the light falls upon a mirror revolving uniformly at a high velocity, and the spot of light thus thrown upon a traveling band of paper appears as a sinuous line, which, if desired, may be fixed photographically.

The importance of investigating this side of the subject appears especially in connection with the parallel running of alternators, in which it is desirable to secure synchronism so far as practicable. The oscillations which appear in such cases are often due to variations in angular velocity of the engines by which the alternators are driven.

The best method of reducing the amplitude of the variations depends upon circumstances. Thus the indiscriminate increase of fly-wheel weight may do more harm than good, since any variation in the loading of

one machine may be sluggishly followed by the other because of the great inertia to be overcome. When the fly-wheel is very heavy it also renders the motion less sensitive to the action of the governor, especially in the case of automatic engines. The whole problem should be taken under consideration in the original design of the engines, and the nature of the valve gear and the distribution of both the reciprocating and rotating masses should be undertaken in view of the work to be done. The coefficient of fluctuation, to use Rankine's term, which has ordinarily been taken as 1/100 as an extreme, should, according to Dr. Franke, be taken as not greater than 1/200 for engines driving alternators running in parallel, or indeed for electric generators in general. In any case there is little doubt that the periodical angular variations in speed occurring during each revolution are of as great importance as the total speed variations themselves.

A Study of Bridge Deflections.

AMONG the numerous valuable papers presented at the Mechanical Congress at Paris was one by M. Rabut, Chief Engineer of the Ponts et Chaussées, upon the experimental study of bridge deflections. This paper, together with the discussion is now made generally accessible in the pages of the *Revue Générale des Chemins de Fer*, and will be found to contain much of interest.

It is not unusual to determine the total deflection of a bridge-girder or truss under a maximum loading, but M. Rabut goes much further, and employs an automatic recording device, which enables not only the extent but the duration, and general nature of the deflections to be obtained in form for permanent study and preservation.

The design of such a recording device is simple, but its construction involves a number of minor details which must be considered if satisfactory results are to be obtained. In the various forms of apparatus suggested by M. Rabut, and made by such accomplished mechanicians as Bourdon, Usteri, Schroeder van der Kalk and Kist, the deflections are multiplied by levers, and recorded upon drums moving with a determinate velocity, so that the time-sequence of the deflections is recorded on a scale sufficiently great to be clearly intelligible.

Without going too fully into the details of the method and apparatus, it will be of interest to examine some of the results which are attained.

When a bridge is subjected to a continual traffic consisting of a variety of loads and impacts, it is in a continual state of tremor. This is the case with the city bridges over which is pouring the multitude of omnibuses, carts, wagons, carriages and foot passengers. In such instances the diagram is practically uniform, consisting of a definite number of vibrations per second, varying occasionally in amplitude, but sinusoidal in form, and representing, undoubtedly, the period of vibration of the span or beam, just as the string of a musical instrument has its note. This is clearly seen in the diagram made by the application of the recording instrument to the *Pont des Saints Pères* in Paris. The vibrations are seen to be regularly four every second, and are almost as uniform as those of a tuning fork. When a highway bridge is subjected to a heavy moving load, concentrated within a limited length, the action is clearly indicated in the diagram. Thus the passage of a heavy road roller over the *Pont J. F. Lépine* shows the manner in which the deflections increase in amplitude, and change in character as the weight moves across the span. The recording apparatus shows also very clearly the effect of a small number of men keeping military step. A diagram produced by the passage of 16 men in military step over the Lépine bridge at Paris shows a far greater amplitude in vibration than that produced by a heavy road roller, the period of vibrations remaining practically unchanged, although the amplitude was increased.

The effect of the passage of a railway train is naturally altogether different from that of the loads on a highway bridge. The sudden impact of the train is followed by a rapid recovery, and this again by successive undulations, gradually passing away as the train passes on. The periodicity of the bridge itself is practically lost in the heavy external forces and the extent and nature of the record depends upon the magnitude and suddenness of the impact.

M. Rabut gives a number of such diagrams, showing the effect of various speeds and loads, and his researches enable the action of moving loads on bridges to be studied intelligently.

REVIEW OF THE AMERICAN PRESS

Balancing Marine Engines.

Two papers were presented before the Society of Naval Architects and Marine Engineers at its recent meeting in New York, both treating of the important subject of the balancing of marine engines. One of these was by Naval Constructor D. W. Taylor, U. S. N., who first made public the method known by the names of Yarrow, Schlick, and Tweedy, and variously patented in different countries, while the other, although presented anonymously, is known to have been written by Rear Admiral George W. Melville, Engineer-in-Chief of the United States Navy.

Mr. Taylor's paper discusses the problem both from its theoretical and its practical side, considering the four-cylinder method, using unequal crank angles, and shows that the present state of the science is now such that, given an engine, it is possible to determine fully the unbalanced forces developed from it at any number of revolutions. In theory it is possible to balance perfectly any engine. In practice, however, so many weighty considerations, apart from those of balancing, must be taken into account that the design of correctly and satisfactorily balanced engines, which are satisfactory in other respects, is exceedingly difficult.

A ship vibrates just like any other elastic rod or beam, forming nodes and loops such as are studied in the science of acoustics. These vibrations are originated by the action of the unbalanced forces in the machinery, and the action of these forces is investigated mathematically by Mr. Taylor, taking first a single-cylinder engine, and then extending the equations thus obtained so as to include multicylinder engines. The resulting analytical expressions enable the resultant unbalanced forces to be computed for any system of cylinders at any point of the revolution of the shaft, but they are altogether too complicated to be of direct practical application. By the introduction of graphical methods, however, the examination may be very materially simplified, and made practically available. Having deduced methods which enable the unbalanced forces to be found, Mr. Taylor considers the possibility of reducing or extinguishing these forces. Considering the ordinary type of vertical engines, there are four conditions which must be fulfilled in a perfectly balanced engine.

First. As it revolves the combined center of gravity of the moving reciprocating weights must remain at a constant distance from the axis. When this is the case, there can obviously be no resultant inertia forces, and hence no external force caused by the motion of the reciprocating weigths.

Second. If we substitute for each moving reciprocating weight another one proportional to the product of the weight by its distance parallel to the shaft from a fixed point on the shaft axis, the center of gravity of this derived system of weights must remain at a constant distance from the axis as the shaft revolves.

When this is the case and the first condition is complied with, there can be no external couple due to reciprocating weigths.

Third. The center of gravity of all revolving weights must be in the shaft axis.

When this is the case, there can be no external couple due to reciprocating weights. ternal force due to revolving weights.

Fourth. If for each revolving weight we substitute a weight proportional to the revolving weight, multiplied by its distance parallel to the shaft from a fixed point on the shaft axis, the center of gravity of this derived system must be in the shaft axis.

When this is the case and the third condition is complied with, there can be no couple or moment from revolving weigths.

In applying the method to actual engines Mr. Taylor takes examples from various cruisers in the United States Navy, and

constructs diagrams showing the arrangement of counterweights to close the polygons and complete the balance.

So far as the crank angles are concerned, the equal angles of 120 degrees give the best results with three-crank engines, but when four cranks are used it can readily be chown that equal angles are not the best. Instead, the cranks should be arranged so as to give the most uniform turning moment, and Mr. Taylor shows that when properly arranged, the four-crank engine gives practically the best arrangement practicable, both for turning moments and for balancing.

Space will not permit us to go into the detailed discussion of the methods of drawing the force polygons and the determination of the best crank angles, and for this the engine designer must be referred to Mr. Taylor's original paper. The whole discussion, however, is by far the most complete exposition which has yet been made of the modern method of balancing marine engines, and as such is a very valuable contribution to the literature of marine engineering.

The paper of Admiral Melville, while dealing with the same general solution, takes up another phase, and discusses another method oi accomplishing the same desirable result. After calling attention to the fact that the United States navy has not adopted the method of four cylinders and unequal crank angles, Admiral Melville proceeds to discuss the MacAlpine method of balancing. This method is intended primarily for engines with two cylinders, and consists in connecting the two piston rods to the opposite ends of a vibrating beam, the connecting rod also being connected to one end of the same beam. By a proper proportion of parts this arrangement gives perfect balance as regards reciprocating weights, and any unbalanced couples act athwartships instead of fore and aft, and are not likely to cause objectionable vibration. Since this gives a complete solution of the problem of two-cylinder balance, it can readily be applied to triple and quadruple expansion engines by doubling it, so that it becomes a perfectly general solution.

Admiral Melville goes very fully into the applicability and general advantages of the MacAlpine system, and maintains that he would not hesitate to run a properly proportioned and balanced engine on that system at speeds as high as 1,000 feet piston speed and 100 to 120 revolutions per minute.

The result of both of these papers is to place before the profession the practical methods of balancing marine engines so completely as to enable any designing engineer to make use of either system, so that there is no reason why excessive vibration, due to unbalanced engines, should be permitted.

Modern Piece-Work Methods.

Among the papers presented at the recent convention of the American Society of Mechanical Engineers may be noted that of Mr. H. L. Gantt, upon the bonus system of rewarding labor.

This system is based upon that of Mr. Fred. W. Taylor, and is as follows:

A card is made out, showing in detail the best method (so far as present knowledge goes on the subject) of performing each of the elementary operations on any piece of work, specifying the tools to be used, and setting the time needed for each of these operations as determined by experiments. The sum of these times is the total time needed to complete the piece of work. If the man follows his instructions, and accomplishes all the work laid out for him, as constituting his proper task for the day, he is paid a definite bonus in addition to the day rate which he always gets. If, however, at the end of the day, he has failed to accomplish all of the work laid out, he does not get his bonus, but simply his day rate. As the time for each detail operation is stated on the instruction card, the workman can see continually whether he is earning his bonus or not, and if he finds any operation which cannot be done in the time set, he must at once report it to his foreman. If, on careful investigation by the man making out the card, the workman's statement is found to be correct—that a portion of the task cannot be done in the time stated on the card—a new instruction card is made out, explaining the proper method of working, and allowing the proper time. It is of the greatest possible importance for the moral effect upon the men that errors in making out instruction cards

should be as few as possible. A man must be allowed time only for what is stated on his card, and while a reasonable time must be allowed for each operation, he should fail to receive his bonus if time is lost from any cause whatever. (The foremen also receive, in addition to their day wages, compensation proportional to the number of their men who earn a bonus, and an extra compensation if all of their men earn their bonuses.)

The basis of this system is the differential piece-work plan of Mr. Taylor, with the bonus added, and is altogether removed from the old-fashioned method of fixing piece rates from the records of the total time it has taken to do a job.

It possesses an advantage over direct piece work in that it is more flexible and can be introduced with greater ease and under conditions where piece work proper would be impossible. When it is realized that proper piece work will, in many cases, produce at least three or four times as large an output as ordinary day work, the difficulties of putting directly on piece work men who have been accustomed to doing work in their own way and in their own time would seem to be, and generally is, extremely difficult. While the men who are on day work usually realize that they are not doing all they can do, when they are told that it is possible to do three or four times as much as they are doing they simply do not believe it, and it is very difficult to make them accept as just a piece rate founded on this basis; but a reward in addition to their day rate constantly held before them will finally be striven for by some one, and when one has obtained it others will try for it. In other words, if the instruction card is made out and a substantial bonus offered, time will do the rest.

Naturally the principal difficulty to be expected from such a system would be from the opposition or indifference of the men, but in practice it appears to work all right.

In making a comparison between the bonus system and proper piece work, it will be recognized at once that each has its advantages. If we have a thorough knowledge of all the conditions, and are able to introduce piece work, it is undoubtedly to be preferred; but we must remember that, aside from the injustice, there is nothing so demoralizing as cutting piece rates, and it is not only extremely difficult to make out proper piece rates, but it is still harder to convince men who have been accustomed to working by the day only, that it is possible for them to earn fair wages when proper rates are set. On the other hand, as the bonus is paid to men in addition to their day rate for performing the work in the manner and time called for by their instruction cards, they do not feel so hostile toward the innovation. These cards do not pretend to represent absolutely the best possible method, but the best method we can devise with the present state of our knowledge, and, while they may be changed as our knowledge increases, they are always intended to describe a method which is within the ability of a good man to reach. The difficulty of introducing such a system is far less than that of introducing direct piece work, for if workmen, having secured to them their day wages, are given such instruction cards, and a considerable reward is held out to them for doing the work in the manner and time called for in the instruction cards, they will gradually overcome their prejudice against following instructions, and finally attempt to perform some of the operations in the time set. Having performed a few of these operations, and finding out that the card represents a fair and reasonable set of instructions, they will, in a short while, conclude that they might as well have the extra pay, and gradually learn to follow the whole card. This has been the experience of the writer, and he was surprised to find out how quickly the men overcame their prejudice. Before the introduction of the bonus, no man was willing to ask somebody else to hurry in order that he might get his work done, for the man spoken to would resent such a request as an insult. Men seldom complained to a foreman that they were being interfered with, but simply sat down and waited, and would sometimes wait for a crane by the hour. Now all are up in arms against anybody who does not serve them almost instantly.

The whole idea of the remuneration of labor, when treated as indicated in Mr. Gantt's paper, is that of individualism, as compared with collectivism under the old system. According to the trades union

idea, the men are considered as a whole, and generally as opposed to the employers, also considered as a whole. Under the new idea each man is practically in business for himself, and his fellow workmen, while not his competitors, so far as his own work is concerned, are not his partners, but are also independent business men. The method conduces not only to independence on the part of the men, but also to their general elevation, and especially does it tend to sort out the capable and skilful men, and relieve them from the burden of their less willing or less competent companions. In the long run it must also tend to the general prosperity of the community in which they live, since it permits the establishment for which they are working to command a larger market because of its more efficient management, thus increasing the demand for their labor as well as the price which is paid for it.

Hydraulic Problems.

We have frequently referred in these columns to the peculiarly elusive nature of the problem of the determination of the velocity of flowing water, and notwithstanding the study which has been given the subject it is evidently far from being exhausted.

In a paper presented before the American Society of Civil Engineers, and published in the *Proceedings* of that society, Mr. Charles H. Tutton discusses the question of the flow of water, taking into account the influence of viscosity. It is well known that in a flowing stream the maximum velocity is found, not at the surface of the water, but at some point below the surface, but no satisfactory explanation has yet been offered for this phenomenon.

The usual method employed in text books is to assume that the mass of liquid is a body of invariable volume, sliding down an inclined plane under the influence of gravity, just as a solid weight would do. This method gives correct results only in the case in which the axis of the curve which represents the curve of mean velocity is found in the free surface, a state of affairs which seldom or never exists. As a matter of fact the total resistance to the motion of the water is composed of two entirely different yet mutually dependent elements, one being the so-called friction along the bed and sides of the stream, while the other is composed of the internal resistances in the water itself, or the so-called viscosity.

Examining the conditions of flow according to Bernouilli's theorem, Mr. Tutton shows that the flow in a liquid is really caused by the pressure on the end section, which pressure is due to a head of liquid measured by the sine of the slope, and which acts uniformly over the section and normal in direction to the line of action of gravity.

The usual treatment for viscous resistance, following the method of Navier, results in a velocity curve of the form of a parabola. Mr. Tutton, however, by examining the frictional resistances between elementary filaments of the liquid, shows that the curve of velocity is an ellipse, the semi-axes of which are the maximum velocity and the distance of that maximum velocity from the bed of the stream. From this treatment he develops equations for the computation of the mean velocity and for the depth at which this mean velocity may be found, and computes a table of the elements of elliptic head, momentum, and kinetic velocity.

As Mr. Tutton well remarks, it appears natural that the branches of the curve of velocity should be tangent over the point of maximum velocity, and that it should terminate tangentially to the bed. It would seem that a curve abruptly cut off at the bed should slip along it. It is hard to conceive the fluid torn apart as would be required by parabolas, hyperbolas, etc., and the ellipse seems to be the proper curve.

So far as the fact of the location of the point of maximum velocity beneath the surface is concerned, it is altogether natural that it should be so placed when we consider the impelling force of the stream to be the slope head acting as a pressure over the end section of the prism. The prevailing notion appears to have been that somehow the upper surface of the water slid along over the layers beneath it, and should have the maximum velocity, whereas the law enunciated by Mr. Tutton shows that the entire prism is practically pushed along by forces acting over its entire section, and it is not to be expected that the maximum velocity should be on one edge of this prism, so to speak.

The paper contains a mass of valuable

information concerning the theory of the flow of water, and while it is to be expected that the treatment of the subject will elicit much discussion and criticism, it appears to open up a line of study which should yield very fruitful results in this much debated field of practical engineering.

The Mining Engineers in Mexico.

SOCIETY conventions are not such uncommon affairs as to demand especial notice in most instances, but the recent visit of a party of the American Institute of Mining Engineers to Mexico was such a success that some brief notice of it is appropriate. From a very complete account of this trip published in the *Engineering and Mining Journal* a brief abstract is here made, and interested engineers are referred to the fuller account for details.

Mexico has long been considered the pioneer mining country in America, and for 160 members of the national mining society to make a special trip through its most famous mining regions, escorted and welcomed by the eminent leaders in science and industry of the different localities, was an event which must yield important results.

Although Mexico has been considered as a great silver producing country for centuries, and is rapidly increasing its gold production there are other minerals which must also be considered when its mineral wealth is discussed. Copper is rapidly becoming of great importance, and to the mines at Boleo, Nacosari, and elsewhere, it it believed that others will soon be added. Coal, iron, manganese, etc., form much of the mineral wealth of Mexico, and to these it is not improbable that fuel oil may possibly extend from Texas into Mexico.

As Mr. Olcott, the president of the American Institute of Mining Engineers, said in his response to the address of welcome of Ing. Don Augustin Aragon, the Minister of Industrial Encouragement, the United States, at the time of the development of the Comstock lode and other mines of early date, turned to Mexico to obtain skilled miners. For the treatment of ores the pan mills of the Washoe district were but the patio process of the Mexicans with the arrastras made of iron. The whole nomenclature of western mining in the United States is based on Spanish terms, and on the one point in which Mexican practice was departed from, that of mining law, the change was for the worse and not for the better.

The technical papers presented at the convention related naturally to subjects belonging mainly to Mexican methods, and the more important must be reserved for notice hereafter, and the main importance of the meetings must be considered as relating to that which was seen rather than heard. Mexico has been so isolated, so dependent upon its own resources, and has made such good use of its great natural wealth that it could teach the visitors much of value.

Not the least important result of this convention will be the close relations and better understanding of the engineers of the two republics as to each other's materials and methods, a result which will be strengthened by the visits of Mexican engineers to the United States which must follow the courtesies shown and acquaintances made at the Mexican convention of the American Institute of Mining Engineers.

Endurance Tests of Automobiles.

WE have reviewed at length in another place the subject of automobiles for military service, showing the severe conditions which must be met before any practical results of value can be expected in that service. As bearing upon this subject we may examine the actual performance of some of the leading machines in the recent run from New York city to Rochester, taking as the basis of our comments the reports given very fully in the *Automobile Magazine*.

As the distance actually traversed was nearly 400 miles, and as the roads, while by no means good, were better than the average in the United States, the results may be considered as affording good practical information. Eighty vehicles started, and but forty-one arrived in time for record by the control, and instructive lessons may be drawn both from the successes and from the failures, especially from the latter.

The general condition of the automobile question at the present time is well expressed, so far as endurance is concerned, by the remark in the articles above referred to: "It would be impossible to have seventy or eighty vehicles go on any kind of a run lasting over a day, without some needing

overhauling to a more or less degree after the first one hundred miles." As a matter of fact practically all the machines needed a great deal of overhauling, although nearly all of them had been most carefully examined and prepared for the trials. No restrictions were placed upon the amount of repairing which the contestants were allowed to make, and no limitations upon the number or nature of spare parts carried or provided. As a result some of the contestants had a large supply of spare parts sent on by train, or carried in supply wagons, and some had expert mechanics who traveled by train and worked at night, putting the vehicles in repair for the next day's work. Thus the 30-horse Panhard vehicle which arrived first at the destination doubtless maintained its record by the manner in which provision had been made for repairs and renewals. One mechanic rode on the machine with the driver, and two more were sent ahead to be ready at each of the controls, with a large box of tools and materials, the two men going over the vehicle every night, and putting it in perfect shape for the morning's journey. So far as endurance is concerned, this practically made the trials single day's runs, each properly being a fresh start with a fresh machine.

As in previous tests elsewhere, the weak points in the machines were elsewhere than in the motive power. Some difficulty was experienced with the electric ignitions in wet weather, but this is a detail which can be readily remedied. The principal defects appeared in the running gear. Wheels, tires, and axles were the chief sources of trouble, and this is only what might have been expected.

To propel a vehicle by turning the wheels from the hub is a far different thing than for the wheels merely to sustain the load and be drawn by horizontal forces acting on the axle. When to this is added the use of large pneumatic tires, with all their possible ailments and weaknesses, it will be realized that here is the place for improvers of automobiles to direct their energies. If these are the facts with pleasure or touring vehicles, how much more important do they become for vehicles for commercial or military service. Speed is all very well, but durability comes first, and in practice it is durability on rough roads, in wet or slippery weather, up heavy grades, and under only average conditions, rather than durability on the parkway or the race track, which must be attained.

The automobile question is one which is in the hands of the engineer to solve, and he has solved only a part of it. The motive power is all right. Improvements will come, and will be welcomed, but the present steam and internal-combustion motors are successes. The mistake of following the lines and construction of horse-drawn vehicles in the design of the running gear is one which, already in process of correction, must be rectified completely. This portion of the work is as much of an engineering problem as is the motive power, and it is in the hands of the engineers for solution. Probably improvements will come as a growth of the experience of such trials as that which has been referred to, but much of it must follow the general experience of users as transmitted to the manufacturers. At the same time there is no reason for following lines which are radically wrong, in order that they may be corrected by experience alone, and it is to be hoped that to the present growing list of makers of automobiles there may soon be added some who will forget that carriage builders are in existence or that horses ever lived, and who will make machines on true mechanical lines throughout, machines which will not need portable repair shops as inevitable accompaniments.

Electricity at the New York Navy Yard.

THE machine shops of the New York Navy Yard were destroyed by fire in the spring of 1899, and with the necessity for the entire rebuilding came the question of the introduction of electric driving. This has been undertaken in very complete style, and the new plant is now in operation and is very fully described in a paper by Mr. F. N. Kollock, Jr., in the *Journal of the American Society of Naval Engineers.*

After a careful examination of the relative merits of the alternating and direct-current systems, the decision was made in favor of the former. This decision was made in view of the superior advantages of alternating currents for transmission over considerable distances, transformers being used at the points of application.

The new buildings include a machine shop, 350 by 130 feet, an erecting shop, 252 by 130 feet, and a boiler shop, 300 by 96 feet, all the buildings being fire-proof and all equipped with modern tools. The power used throughout the steam engineering shops, with the exception of that for cranes, is furnished by alternating-current motors directly connected to the larger machine tools, and belted to countershafting for driving the smaller tools. There are three cranes in the machine shop and three in the erecting shop, these ranging from 10 to 40 tons capacity, all operated by direct-current motors, rotary transformers being used to enable these to derive their current from the main plant.

The generating plant consists of three generating sets, with vertical compound McIntosh-Seymour engines and Westinghouse alternators, the engines being of 630 h. p. each at 136 revolutions, and the alternators having 25 periods per second, two-phase, at 220 volts pressure. The generators have a guaranteed efficiency of 94½ per cent. at full load, and 84 per cent. at ¼ load. Full details of the construction of the generators are given in Mr. Kollock's paper.

The motors range from one of 200 h. p., driving a large air compressor, down to motors from 1 to 30 h. p., these being alterating current two-phase motors for driving the various machine tools and countershafts, there being 60 such motors in all.

The entire plant, while designed in accordance with the most advanced ideas, can in no wise be considered as experimental. Standard apparatus is used throughout, making duplications or possible renewals very easy, and the plant is similar to others which have given excellent satisfaction in actual service.

It is encouraging to see a government plant thus take a place in the front rank of modern equipment methods, refuting the accepted idea that conservatism invariably prevails in such establishments; and where such progressive ideas obtain in official departments we may expect to find private shops following close on their heels.

The Distribution of Electrical Energy.

At a recent meeting of the American Institute of Electrical Engineers there was a "symposium" on the distribution of electrical energy. Eight papers were read by as many authors, each casting the light of his own experience on the subject, which was thus illuminated on all sides.

The first paper was on the "Distribution of Electrical Energy in Large Cities," by Mr. Louis A. Ferguson, who gave an account of the actual conditions existing in Chicago.

"With the trend of modern times towards consolidation of lighting, power and transportation properties, the system of distribution of electrical energy, in large cities especially, is daily becoming a more important question, involving many perplexing problems and considerations. Were one given the problem of determining the system in an imaginary city fully developed in its business and residential portions, its growth matured and freed from the pioneering and bad engineering of the promotion days of electricity, the question would be a comparatively easy one." But it is "a condition and not a theory which confronts us," and the modern consolidators usually find it advisable to adapt their engineering to existing conditions, abandoning as little as possible the investment made by the companies which they absorb. And not only what has been done in the past must be considered, but also the possible development of the future, so that many conflicting quantities enter into the general problem.

"The developments of the last few years have determined conclusively that the old method of installing a multiplicity of steam generating stations scattered throughout the city and furnishing electricity for lighting and power is no longer advisable. We find the more progressive companies abandoning their smaller plants as generating stations, converting some into sub-stations and centralizing the generation of electrical energy in one or two large power stations located preferably on a water front and having direct communication with two or more railroads bringing coal from different sections of the country." Water and coal facilities being equal, the main power house should be as near the center of distribution as possible, the cost of land being a secondary consideration. "In any new principal station the generators should be of the same frequency, even if it is advisable, owing to

local conditions, that one or more be double-current machines. It is always conducive to economy, flexibility of operation and minimum initial investment that all the generators be arranged for parallel operation.

"The determination of the class of current we shall generate depends entirely on the class of current we distribute. Considering the question for a large city from the broadest standpoint, and judging by experience with the advantages and limitations of both forms of distribution, I would recommend direct current for the lighting and power work of the strictly business and city residential districts, and alternating current for the less closely built residential districts with their local business incident thereto, as well as for the actual suburban territory of the city."

An analysis of the lighting and power output (not including railways) of Chicago central station companies where this method of distribution is followed, shows that of a total maximum output of 22,500 kilowatts, over 20 per cent. is by 60-cycle alternating distribution over a territory of approximately 58 square miles and nearly 80 per cent. is by direct current distribution over a territory of only 10 square miles.

"The growth of the business of the company (except in the Southern district, where a modern 60-cycle station operates) is being provided for by 25-cycle rotary sub-stations, and all direct current generating apparatus will be superseded as it wears out or becomes obsolete, by 25-cycle rotary sub-station distribution in one low tension district. As the outlying residence districts become more general consumers of electricity, they are changed over to low tension direct current, and all new development in the Northern and Western districts is supplied by motor generator sets receiving 25-cycle current from the main generating station and delivering 60-cycle current to the distribution lines."

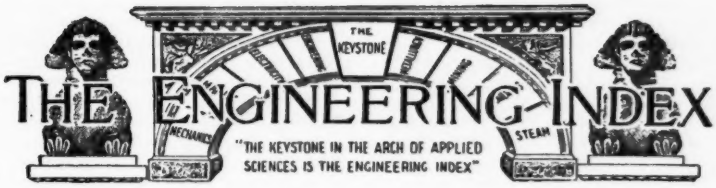
The importance of the power business, which amounts to over thirty per cent. of the total station load of the Central District, led to the adoption of the three-wire direct current system for distribution in this business and residential section. Storage batteries are largely used in this district, there being three batteries in the Adams Street sub-station, having a combined capacity at the eight-hour rate of 66,000 ampère hours, and smaller batteries in three of the rotary sub-stations in the residence district.

Storage batteries are desirable wherever the service of the central station is important. They may be used in various ways: in the central station itself when it is located at the electrical center; at the center of distribution for discharging during the peak of the load; as auxiliaries in the rotary converter sub-stations. But their greatest value is in their ability to carry the system through an emergency which comes, as a rule, with very little warning.

In the outlying Northern, Western and Southern districts of Chicago, 60-cycle alternating current is distributed by a four wire, three-phase system. This current is generated directly at a principal station in the Southern district, and in the Northern and Western districts at motor-generator sub-stations, the motor side being fed by 25-cycle three-phase current from the Harrison Street main station.

Mr. Charles F. Scott, in his paper on "Alternating Current as a Factor in General Distribution for Light and Power," says that at present the only question is between alternating current alone, and alternating generation with direct current distribution. He favors the former method but he admits "that there is no ideal system and no panacea plan which can be universally applied. Existing and local conditions, special requirements and the relative importance of the various classes of service to be rendered must all be taken into account in determining what will be adequate in an individual case."

This is a fair general conclusion to be gained from all the papers which were presented at the meeting, but one or two points seem to be pretty well determined upon: Three-phase current should be generated at large central stations. For general purposes in outlying districts this should be distributed as three-phase or simple alternating current at pressures to suit circumstances; while in the central portions of cities and other places where there is a large local demand, as well as for railway purposes, there should be rotary converter sub-stations from which direct current is distributed.



The following pages form an index to the contents of nearly two hundred of the leading engineering journals of the world, in English, French, German, Dutch, Italian, and Spanish, together with the published transactions of important engineering societies in the principal countries. It will be observed that each index item gives the following essential information about every article.

(1) The full title, (2) The name of its author,
(3) A descriptive abstract, (4) Its length in words,
(5) When published, (6) Where published.

We supply the article itself, if desired.

The Index is conveniently classified into the larger divisions of engineering science, to the end that the busy engineer and works manager may quickly turn to what concerns himself and his special branches of work. Thus this Index makes it possible within a few minutes' time each month to inform one's self of every important article published anywhere in the world upon the subjects claiming one's special interest.

The original of any article referred to in the Index, together with all illustrations, can be supplied by us. See the "Explanatory Note" at the end, where also the full titles of the journals indexed are given.

CONTENTS.

Civil Engineering	617	Marine and Naval Engineering	630
Electrical Engineering	622	Mechanical Engineering	632
Gas Works Engineering	628	Mining and Metallurgy	640
Industrial Economics	629	Railways and Tramways	644

CIVIL ENGINEERING

BRIDGES.

Approach.

The Rankin Bridge. Illustrated detailed description of a bridge across the Monongahela River, at Rankin, Pa., notable for the massive construction required, and for the special design of the river end of the south approaches. 4500 w. Eng Rec—Nov. 16, 1901. No. 44405.

Bascules.

Some Old Examples of Bascule Bridges. K. Hellenthal. An illustrated description of bridges of this type, or based on similar principles, built before the patents for the bascule bridges were issued. Ill.

We supply copies of these articles. See page 649.

1500 w. Jour W Soc of Engrs—Oct., 1901. No. 44156 D.

Bridge Design.

"Monumental" Engineering. Montgomery Schuyler. A critical discussion of the designs for the Memorial Bridge across the Potomac from Washington to Arlington. Ill. 7700 w. Archt Rec—Oct., 1901. No. 44117 C.

The Architectural Treatment of Bridges. Illustrated extracts from *The Builder*, giving suggestions for designing piers and spandrel facings of flat masonry arches. 2200 w. Eng Rec—Nov. 2, 1901. No. 44148.

Brooklyn Bridge.

The New York and Brooklyn Bridge. Review of the report of expert engineers appointed to make an examination of the bridge. 3000 w. Engr, Lond—Nov. 1, 1901. No. 44309 A.

Concrete Arch.

New Concrete Arch Bridges at Niagara. Orrin E. Dunlap. Illustrated description of the bridges built at Niagara Falls to connect the mainland and Goat Island. 1000 w. Sci Am—Nov. 23, 1901. No. 44467.

Continuous Girder.

A Diagram for Finding Pier Moments on Continuous Spans. C. E. Young. Diagram with explanation, illustrated by examples. 900 w. Eng News—Nov. 14, 1901. No. 44387.

Draw-Bridge.

New Street Railway Draw-Bridge at New Bedford, Mass. William F. Williams. An illustrated detailed description of this bridge and its operation. There is a double-track electric railway line the entire length of the bridge. 1800 w. St Ry Rev—Nov. 15, 1901. No. 44463 C.

East River Bridge.

Building the Approaches of the New East River Bridge. Brief description with illustration of the new bridge across the East River, New York. 1000 w. Sci Am—Nov. 16, 1901. No. 44365.

Masonry Arches.

The Design and Construction of Masonry Arches. William D. Pence. Discusses the masonry arch from a practical point of view, and briefly considers the concrete-steel construction. 5000 w. Indiana Engng Soc, 1901. No. 44417 D.

The Rockville Stone Arch Railway Bridge. Illustrated description of a 4-track masonry bridge, 3,820 ft. long, having 48 arches of 70-ft. span. Explains the design and method of construction. 1700 w. Eng Rec—Nov. 9, 1901. No. 44210.

Melan Arch.

Melan Arch Park Bridges at Washington, D. C. W. J. Douglas. Illustrates and describes the construction of two concrete-steel bridges built for the U. S. government, with particulars concerning the work, and the subsequent cleaning made necessary by discolorations. 2400 w. Eng News—Oct. 31, 1901. No. 44108.

Redheugh Bridge.

The Redheugh Bridge. Two-page plate and other illustrations of the details of the piers, approach spans, and roadways of the structure, with description. 1200 w. Engng—Nov. 8, 1901. No. 44337 A.

Renewal.

A Railway Bridge Renewal. Illustrates and describes the removal of a bridge, where a railway intersected a railway, with as little interruption of traffic as was possible. 1600 w. Engr, Lond—Nov. 15, 1901. No. 44623 A.

Shop Work.

Modern Practice in Bridge Shop Work. W. H. Pratt. A brief paper on the development of these shops, with discussion. Ill. 1200 w. Jour W Soc of Engrs—Oct., 1901. No. 44155 D.

Superstructure.

Superstructure of the Interprovincial Bridge, Ottawa. F. P. Shearwood. An illustrated description of the superstructure of the bridge recently erected at Nepean Point, Ottawa. Plates. 3200 w. Can Soc of Civ Engrs—Adv. proof—Nov. 21, 1901. No. 44633 D.

Suspension.

A Stiffened Suspension Bridge on a Steep Incline at the Westport-Cardiff Coal Company's Mine, New Zealand. Thomas Harold Rawson and George Herbert Broome. Presented to the Inst. of Civ. Engrs, of Gt. Britain. Describes the conditions which only permitted the most economical design consistent with required strength, and rapid erection. Illustrated description. 1600 w. Eng News—Nov. 14, 1901. No. 44388.

Testing.

Experiments on French Metal Bridges. Description of experiments on girder and truss bridges indicating that the distribution of stresses in the various members is different from the usual assumptions made in engineering designs. 1700 w. Eng Rec—Nov. 9, 1901. No. 44209.

CANALS, RIVERS AND HARBORS.

Dredging.

Heavy Dredging with Light Machinery at Havana. A. H. Weber. A description of heavy rock and clay excavation with machinery too light for the work, causing delays by break downs and large sums for repairs. 1100 w. Eng Rec—Nov. 23, 1901. No. 44495.

We supply copies of these articles. See page 649.

Dry Dock.

The Caisson at the Kiel Drydock. Illustration, with brief description of a huge caisson costing about $250,000. 450 w. Sci Am Sup—Nov. 2, 1901. No. 44099.

Floating Dock.

Floating Dock for Khartoum. Drawings and description. 1400 w. Engr, Lond—Oct. 25, 1901. No. 44137 A.

Harbor Cranes.

Erection of 120 Ton Shears at the Port of Havre (Mise en Place d'une Bigue de 120 Tonnes dans le Port de Havre). Ch. Dantin. Illustrated description of the powerful new shears recently erected at Havre, with photograph showing the method of erection. 1800 w. 1 plate. Génie Civil—Nov. 9, 1901. No. 44508 D.

Floating Crane for Rio de Janeiro (Schwimmender Mastenkrahn für den Hafen von Rio de Janeiro). H. Frahm. Illustrated description of 80-ton floating shears built for the Brazilian government. 1200 w. Stahl u Eisen—Nov. 15, 1901. No. 44543 D.

Harbor Works.

The New Harbor Works at Dover. Describes the works under construction, giving plan and chart and explaining their importance and the advantages to be secured. 3400 w. Nineteenth Cent—Nov., 1901. No. 44322 D.

Inclined Plane.

Inclined Planes for Canal Locks (Frogschleusen auf Geneigten Fahrbahnen). Jaroslav Gröger. With especial reference to the overcoming of differences of level on the Danube-Moldau Canal. Two articles. 10,000 w. 1 plate. Zeitschr de Oesterr Ing u Arch Ver—Nov. 19, 1901. No. 44528 each B.

Land Protections.

The Practical Building of Lowland Protections. Percy H. Wilson. Abstract from a thesis presented to the Civ. Engng. Dept. of the Univ. of Penn. The practical building of banks with their protections, with sketches showing detailed plans of constructions in each class, noting their advantages and disadvantages. 7300 w. Pro Engrs' Club of Phila—Oct., 1901. No. 44431 D.

Land Reclamation.

The Reclamation and Irrigation of the Kistna Delta, India. An illustrated account of this work, abstracted from an article by George T. Walch, published as a government document at Madras. 3300 w. Eng News—Nov. 7, 1901. No. 44280.

Lighthouses.

Building the New Beachy Head Lighthouse. Harold J. Shepstone. Illustrated description of a lighthouse erected on a wave-washed rock, 550 ft. from the cliffs, as the lighthouse on the promontory is frequently obscured by fogs. It will be, when completed, one of the finest lighthouses on the English coast. 1800 w. Sci Am—Nov. 9, 1901. No. 44229.

Steel Lighthouse Construction. Waldon Fawcett. Relating to changes proposed in these structures, providing the United States government decides to erect additional towers of this type. Ill. 1600 w. Am Mfr—Nov. 21, 1901. No. 44480.

Mississippi.

Bank Revetment on the Lower Mississippi River. Charles Le Vasseur. Read before the Memphis Engng. Soc. Illustrates and describes the revetment work; the making of the mattress, the launching, etc. 2700 w. Eng News—Oct. 31, 1901. No. 44107.

Nicaragua Canal.

The Nicaragua Canal Project S. D. Webster. A critical discussion of a paper by W. K. Kavanaugh, read at the Industrial Convention at Philadelphia. 4500 w. St. Louis Ry Club—Nov. 8, 1901. No. 44636.

Protective Works.

Proposed Permanent Protective Works for Town of Dera Ghazi Khan. Specification of work which is not only to stop the invasion of the river Indus, but cause it to restore the land washed away. Ill. 2000 w. Ind and East Engr—Oct., 1901. No. 44499 B.

CONSTRUCTION.

Building Construction.

Reconstructing the Morse Building, New York. Illustrated description of the methods employed in building an 8-story steel cage structure on top of one of the oldest office buildings in the city. 3100 w. Eng Rec—Nov. 2, 1901. No. 44146.

Dome.

The Students' Hall Dome, Columbia University. Illustrates and describes the construction of a tile dome 48 1/3-feet in diameter inside, with a total rise of about 68 feet. It is of the Guastivino construction. 700 w. Eng Rec—Nov. 23, 1901. No. 44497.

Excavating.

Steam Shovels for Trench Excavation. Illustrated description of work upon which this method of excavation has been employed. 1400 w. Eng News—Nov. 7, 1901. No. 44277.

Fireproofing.

The Protection of Iron Construction Against Fire (Die Hulfsmittel zum Schutze des Eisens gegen Feuersgefahr). M. Gary. Describing the fireproofing

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methods shown at the Berlin exposition, 1901. 2000 w. Stahl u Eisen—Nov. 1, 1901. No. 44540 D.

Floor Tests.

Fire and Weight Tests of Columbian Fireproof Floor; Boston, Mass., July, 1901. Frank P. McKibben. An illustrated account of tests made to demonstrate the capacity of this system when under heavy loads to resist the action of fire and water. 900 w. Eng News—Nov. 21, 1901. No. 44473.

Weight Tests of Rapp Floor Arches. Illustrated description of 6, 10 and 12 ft. arches of brick on light iron frames, tested with loads up to 3,000 lbs. per sq. ft. without serious deflection. 400 w. Eng Rec—Nov. 9, 1901. No. 44212.

Framework.

Metallic Construction (Constructions Métalliques). An examination of the stresses in framed structures with especial reference to roof trusses. 1500 w. Revue Technique—Oct. 10, 1901. No. 44549 D.

Girders.

Heavy Girders in the Union Club House. Illustrated description of the construction, especially the heavy girders. 1300 w. Eng Rec—Nov. 16, 1901. No. 44410.

Piers.

An Austrian Investigation of Masonry Piers. Abstract of the report of tests on the compressive resistance of masonry, made by order of the Austrian Soc. of Engrs & Archts. Ill. 3300 w. Eng Rec—Nov. 23, 1901. No. 44493.

Pile-Driver.

A New Pile Driver, Boston & Maine R. R. Illustrated description of an exceedingly strong and serviceable machine showing modern improvements. 1000 w. Ry & Engng Rev—Nov. 9, 1901. No. 44,270.

Reinforced Concrete.

Concrete-Iron Construction (Ueber Betoneisen Konstruktionen). S. Rappaport. A discussion of the stresses in floor construction, showing the lateral strains induced upon the walls of the building. 2000 w. Schweizerische Bauzeitung—Nov. 2, 1901. No. 44557 B.

Recent Examples of Concrete-Iron Construction (Neuere Bauweisen und Bauwerke in Beton und Eisen). F. v. Emperger. With illustrations of pier and wharf construction. Serial. 2500 w. Zeitschr d Oesterr Ing u Arch Ver—Oct. 25, 1901. No. 44527 B.

Roads.

Can Present Standard Road Specifications Be Improved. Halbert Powers Gillette. Calls attention to certain clauses in the "standard specifications" for macadam road-work as practiced in New York and Massachusetts. 3800 w. Eng News—Nov. 7, 1901. No. 44279.

Suggestions for Road Building in Tennessee. Hunter McDonald. Extracts from a paper presented to the Tenn. Good Roads Convention. Discusses gradients, materials, drainage, etc. 1500 w. R R Gaz—Nov. 15, 1901. No. 44396.

Sanitary Buildings.

Sanitary Architecture. A lecture on design, materials, buildings, workmanship and supervision at the Carpenters' Hall, London, by Mark H. Judge. 2800 w. Archt, Lond—Nov. 8, 1901. No. 44323 A.

Skeleton Buildings.

The Steel Work in Skeleton Buildings. William Copeland Furber. Discusses rust prevention and fireproofing. 2000 w. Ins Engng—Nov., 1901. No. 44122 C.

Tunnels.

Progress of Construction of the Rapid Transit Tunnel. An outline of the satisfactory progress made on the New York tunnel, with map and editorial. 3000 w. Sci Am—Nov. 2, 1901. No. 44095.

Some Methods of Construction of the Rapid Transit Subway. Views taken at various points, illustrating methods and showing progress, with description. 1300 w. Sci Am—Nov. 9, 1901. No. 44230.

The Construction Works of the Simplon Tunnel (Die Bauarbeiten am Simplontunnel). S. Pestalozzi. Describing especially the auxiliary works in connection with the tunnel, including the water-power plants, etc. Serial. Part I. 2000 w. Schweizerische Bauzeitung—Nov. 2, 1901. No. 44556 B.

Tunnelling. Review of a practical treatise by Charles Prelini, with additions by Charles S. Hill, placing on record the distinguishing characteristics of tunnelling methods practised in the present day. 5600 w. Builder—Nov. 9, 1901. No. 44341 A.

Work on the Simplon Tunnel. Comments on the engineering work and the advantages of this route through the Simplon Pass, over the Mt. Cenis and St. Gothard. Ill. 2000 w. Sci Am—Nov. 16, 1901. No. 44368.

See also Railways and Tramways, Permanent Way.

MATERIALS.

Asphalts.

Asphalts—Their Sources and Utilization. T. Hugh Boorman. Discusses the various kinds of asphalt and their adaptability for different methods of construction. 1800 w. Archts & Build's Mag—Nov., 1901. Serial. 1st part. No. 44,175 C.

Cements.

American Portland Cements. S. B.

Newberry. A brief study of the manner in which American engineers have solved the chemical and mechanical problems of adapting its manufacture to American conditions. 2300 w. Indiana Engng Soc—1901. No. 44415 D.

Cement for a Modern Street. Dr. S. F. Peckham. Briefly describes the different cementing materials experimented with in the construction of concrete foundations, giving the details of the process of manufacture of Portland cement. Ill. 4200 w. Pop Sci M—Dec., 1901. No. 44615 C.

Tests of American Slag Cements. William Kendrick Hatt. A statement of the nature and properties of slag cements and a report of the results of tests performed at Purdue University on five kinds of American cement made from blast furnace slag as one element in the product. 6000 w. Indiana Engng Soc—1901. No. 44416 D.

The Chemical and Physical Properties of Portland Cement. B. Brentnall Lathbury. Brief notes on the important ingredients, physical properties and tests. 1000 w. Br Build—Nov., 1901. No. 44,638 D.

The Determination of Alkalies in Portland and Natural Cements. Thomas B. Stillman. Explains the scheme for the anaylsis. 1400 w. Stevens Ind—Oct., 1901. No. 44079 D.

The Relative Merits of Portland and Natural Cements for Street Foundations. C. H. Rust. Discusses the advantages of Portland over natural cement. 800 w. Munic Engng—Nov., 1901. No. 44159 C.

Concrete.

The Use of Concrete. Victor K. Hendricks. Gives instructions and suggestions for obtaining good work. 9000 w. Indiana Engng Soc—1901. No. 44414 D.

Timber Preservation.

Methods of Injecting Timber (Du Controle de l'Injection et de la Reception des Bois Injectés). M. Vinsonneau. An examination of the various antiseptic solutions and methods used for the preservation of timber. 2000 w. Revue Technique—Oct. 10, 1901. No. 44550 D.

Wooden Columns.

The Computation of Wooden Columns Against Buckling (Berechnung der Hölzernen Säulen auf Knickfestigkeit). Max R. v. Thullie. With tables and curves computed from Tetmajer's formula. 1000 w. Zeitschr d Oesterr Ing u Arch Ver—Nov. 8, 1901. No. 44530 B.

MUNICIPAL.

Pavements.

Asphalt Pavements in the Borough of Manhattan, New York. Edward P. North. A review of the statistics of asphalt laid in 10 years under different requirements, pointing to a 15-year guaranty as the most economical term to require. 2400 w. Eng Rec—Nov. 2, 1901. No. 44144.

Pavement Guarantees. George W. Tillson. Considers the practice in detail, giving the writer's opinion of the proper requirements and the principals governing in each case. 4000 w. Munic Engng—Nov., 1901. No. 44158 C.

The Possibilities of the Use of Coal Tar in Bituminous Pavements. Fred J. Warren. Discusses points to be considered in selecting material, and the conditions on which the life of bituminous pavements depend. 2300 w. Munic Engng—Nov., 1901. No. 44157 C.

Sewage Disposal.

Sewage Disposal in Summer Resorts. Dr. P. H. Bryce. Simple, inexpensive, practical suggestions for places without sewerage systems. Ill. 2000 w. Can Archt—Oct., 1901. No. 44161 C.

New Sewage Screening Apparatus at Manchester. A description of works for removing detritus from the sewage before it passes through the disposal works. 1000 w. Eng Rec—Nov. 16, 1901. No. 44409.

Septic Tanks and Contact Beds at Plainfield, N. J. Andrew J. Gavett. An illustrated description of a new plant consisting of two septic tanks and a double set of bacterial contact beds. 1700 w. Eng Rec—Nov. 16, 1901. No. 44407.

WATER SUPPLY.

Ozone.

Water Purification by Means of Ozone. Brief illustrated description of an experimental plant erected in Berlin some three years ago. 900 w. Elec Engr. Lond—Nov. 8, 1901. No. 44330 A.

Protection.

Protection of Water Supplies. Gives abstracts of three papers and their discussion, as presented to the recent conference on Water Supply and Pollution, in England. Deals with the protection of watersheds, underground supplies, and the rights of underground pumping. 8500 w. Jour Gas Lgt—Oct. 29, 1901. No. 44284 A.

Rainfall.

Rainfall and Village Water Supplies. Abstracts of papers with the discussions thereon, presented to the Conference on Water Supplies and River Pollution. 9700 w. Jour Gas Lgt—Nov. 5, 1901. No. 44300 A.

Reservoirs.

The Failure of the East Liverpool Reservoir. Illustrated description of a concrete-lined reservoir bank 23 ft. deep, which failed where the drain pipe passed through it. 500 w. Eng Rec—Nov. 2, 1901. No. 44151.

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Spillways.

Spillways and Drainage Areas. E. Sherman Gould. A discussion of Mr. Frizell's formula. 2200 w. Eng News—Nov. 14, 1901. No. 44389.

Tank Failure.

The Failure of the Elevated Water Tank at Fairhaven, Mass. An illustrated description of a tank having a curved bottom, with report of the failure and views of the wreck. 2800 w. Eng News—Nov. 21, 1901. No. 44476.

The Collapse of the Fairhaven Water Tower. Describes the tower and the accident. 1300 w. Eng Rec—Nov. 16, 1901. No. 44413.

Wells.

Experimental Well Boring (Versuchsbrunnenanlagen). H. Prinz. A discussion of the deductions to be made from borings to determine the nature of groundwater seams for water supply. 3000 w. Zeitschr d Ver Deutscher Ing—Nov. 9, 1901. No. 44524 D.

MISCELLANY.

Engineering Profession.

The Duty of the Engineer. A topical discussion. I. To Himself and His Profession. Edgar Marburg. II. To His Clients or Employers, John Birkinbine. III. To His Contractors and Employees, L. Y. Schermerhorn. IV. To the Public, John C. Trautwine, Jr., with general discussion. 1600 w. Pro Engrs' Club of Phila—Oct., 1901. No. 44430 D.

The Position of the Engineer in Municipal Service. Alex. Dow. Presidential address before the Detroit Engng. Soc. How to divorce public business from politics. 5800 w. Jour Assn of Engng Soc—Sept., 1901. No. 44112 C.

Exposition Buildings.

Coloring and Decorating the Pan-American Exposition. C. Y. Turner. Read before the Am. Inst. of Archts. Gives an account of the things needing to be considered in working out the color scheme and the need of early consultation of architect, sculptor, colorist and landscape architect. 4500 w. Am Archt—Nov. 16, 1901. No. 44345.

Forestry.

The Forester, an Engineer. B. E. Fernow. An illustrated article showing the many applications of engineering knowledge to the business of wood production. Also discussion. 7200 w. Jour W Soc of Engrs—Oct., 1901. No. 44153 D.

ELECTRICAL ENGINEERING

COMMUNICATION.

Australia.

The Telegraph and Telephone Services of Australia. Abstract of the report issued by the Committee of Electrical Experts, as given in the *Melbourne Argus*. 1600 w. Elec Rev, Lond—Oct. 25, 1901. No. 44128 A.

Cable Laying.

Cable Laying in the Philippines. Frederick Moore. An illustrated account of the work and some of the difficulties. 900 w. Sci Am—Nov. 23, 1901. No. 44466.

Cables.

The Philippine Cable and Attending Work. Illustrated description of the difficulties encountered in establishing telegraphic communication in these islands. 1600 w. Elec, N Y—Nov. 13, 1901. No. 44283.

Exchange.

The Automatic Telephone Exchange at Fall River, Mass. Illustrated detailed description of an exchange without a switchboard and without operators. 1800 w. Elec Rev, N Y—Nov. 16, 1901. No. 44361.

The New Bell Telephone Exchange, Cortlandt Street, New York City. An account of the change from the old to the new exchange, with an illustrated description of the new exchange which is operated on the common battery system. The method of operation is briefly explained. 1700 w. Elec Wld & Engr—Nov. 9, 1901. No. 44273.

Space Telegraphy.

Marine Wireless Telegraphy. Editorial on the agreement between the Marconi International Marine Communication Co. and Lloyds. 1800 w. Elect'n, Lond—Oct. 25, 1901. No. 44125 A.

Movable Wireless Telegraphy Apparatus. Brief description of recent experiments by Mr. Marconi. Huge cylinders are used as receivers in place of the high wire, the apparatus being carried by an automobile which makes a speed of 12 to 14 miles an hour. 400 w. Elec Rev, N Y—Nov. 2, 1901. No. 44165.

Syntonic Wireless Telegraphy. A. Frederick Collins. Reviews the various systems, discussing them in detail. Ill. 5300 w. Elec Wld & Engr—Nov. 9, 1901. No. 44274.

Wireless Telegraphic Installation in H. M. Ships. Illustrations showing the manner in which the instruments are set up, with descriptions. 1500 w. Elec Rev, Lond—Nov. 15, 1901. No. 44610 A.

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Storage Batteries.

Storage Battery and Controlling Board. J. W. Ayden. Read at the Convention of the International Assn. of Munic. Elect'ns. On the advantages of storage batteries, especially discussing the lead battery as adapted to fire and police telegraph systems. 1800 w. Fire & Water—Nov. 23, 1901. No. 44482.

Telegraphy.

Telegraph Systems, Operating Speeds and Economies. Romyn Hitchcock. Discusses the present condition of the telegraph, the reasons why the service is slow and costly, and the directions to look for improvements. 3000 w. Elec Wld & Engr—Nov. 16, 1901. No. 44383.

Telephony.

Some Notes on Bell's Telephone. Fred Deland. Gives in detail the steps that led to the invention of Bell's telephone. 8700 w. Telephony—Oct., 1901. No. 44089.

DISTRIBUTION.

Boosters.

Improvised Boosters. Walter M. Hollis. Discusses the use of a booster and an additional feeder, the conditions under which a series booster operates, and describes the construction of a booster. 2000 w. Am Elect'n—Nov., 1901. No. 44236.

Multiple-Wire.

The Balancing and Feeding of a Multiple-Wire Network. O. Dewey. Considers that the best arrangement for a large cross-connected network would be to have most of the feeders two-wire ones, and have a few multiple-wire feeders, so as to enable the network to be split up into sections for localizing faults. 3000 w. Elec Engr, Lond—Nov. 1, 1901. No. 44297 A.

Power Distribution.

Electric Power Distribution in a United States Navy Yard. An illustrated discussion of the equipment of the Brooklyn Navy Yard and the results obtained. 1800 w. Elec Wld & Engr—Nov. 2, 1901. No. 44194.

The Rise of Electric Power Distribution. Alton D. Adams. An examination of motive power statistics showing the growth. Also editorial. 4000 w. Elec Wld & Engr—Nov. 2, 1901. No. 44195.

Regulation.

Regulating Devices for Series Alternating Current Circuits. J. Henry Hallberg. Read before the Ohio Elec. Lgt. Assn. A general illustrated description of regulating apparatus and enclosed arc lamps for series alternating-current circuits, and a practical description of the series alternating-current enclosed arc system, using the reaction coil and shunt-wound arc lamp. 3500 w. Elec Rev, N Y—Nov. 23, 1901. No. 44484.

Rotary Converter.

The Design and Action of the Rotary Converter. D. B. Rushmore. A discussion of the principles and construction of this important apparatus in the transmission and utilization of electric power. 3500 w. Engineering Magazine—Dec., 1901. No. 44578 B.

Three-Wire.

The Three-Wire System. John H. Ryan, Jr. An explanation of why three wires are used and a statement of some of the troubles encountered, and methods of runnng. Ill. 3500 w. Engr, U. S. A.—Nov. 15, 1901. No. 44343.

Wiring.

Interior Conduit Construction and the National Electrical Code. Edward Sullivan. Calls attention to points that should be observed in installing the conduit system of wiring. 2400 w. Elec Rev, N. Y—Nov. 16, 1901. No. 44362.

I. Wiring Rules. C. H. Wordingham. II., Coventry Wiring Regulations, Jos. A. Jeckell. III., Letter, T. P. Wilmshurst. Three communications on the subject of wiring. 4400 w. Elect'n, Lond—Nov. 8, 1901. No. 44331 A.

ELECTRO-CHEMISTRY.

Accumulators.

A Process for Increasing the Capacity of Accumulators. C. Heim. Abstract of a paper read at Dresden meeting of the Verband Deutscher Electrotechniker. Discusses the influence of increase of temperature. 17000 w. Electr'n, Lond—Nov. 1, 1901. No. 44296 A.

Note on a Regenerative Accumulator and Its Application for Using Exhaust Steam. M. A. Rateau. Read before the Glasgow Congress. Illustrates a new apparatus intended to allow the use of the exhaust steam from machines having intermittent action. 700 w. Elec Engr, Lond—Nov. 8, 1901. No. 44329 A.

Acker Process.

The Acker Process for the Electrolytic Production of Alkalies and Chlorine. John B. C. Kershaw. Illustrated description of the process which is in operation at Niagara Falls. 1500 w. Elect'n, Lond—Oct. 25, 1901. No. 44126 A.

Cells.

A New Form of Diaphragm Cell for the Electrolytic Production of Alkalies and Chlorine. John B. C. Kershaw. Reviews briefly the types of diaphragm cells in actual use, and describes the cell patented by Moore, Allen, Ridlon and Quincy. 1500 w. Elect'n, Lond—Nov. 15, 1901. No. 44613 A.

Phosphorus.

On the Effect of Temperature and of Moisture on the Emanation of Phos-

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phorus, and on a Distinction in the Behavior of Nuclei and Ions. C. Barus. Gives experimental investigations made and conclusions reached. 6600 w. Am Jour of Sci—Nov., 1901. No. 44113 D.

ELECTRO-PHYSICS.

Coherence.

Electrical Coherence. S. Alfred Varley. An account of the researches of the writer. 2800 w. Elec Rev, Lond—Nov. 1, 1901. No. 44301 A.

Electrons.

The Development of the Electron Idea. W. Kaufmann. From the *Physikalische Zeitschrift.* Lecture delivered at Hamburg, with editorial. 5200 w. Elect'n, Lond—Nov. 8, 1901. No. 44332 A.

High Frequency.

Electrical Oscillation of High Frequency. Arthur V. Abbott. Outlines the behavior of the three fundamental attributes of every electrical circuit—resistance, inductance, and capacity—showing by illustrations how each acts and the results of their mutual relations. Ill. 7300 w. Jour W Soc of Engrs—Oct., 1901. No. 44152 D.

Induction.

The Law of Magnetic Induction (Das Gesetz der Magnetischen Induktion). E. Müllendorf. A mathematical study of the laws governing induction, with tables showing the close agreement of computed and experimental values. 4500 w. Elektrotech Zeitschr—Nov. 7, 1901. No. 44565 B.

Interrupter.

Some Experiments on the Wehnelt Interrupter. M. A. Codd. An account of experimental investigations into the working of the electrolytic interrupter. 1600 w. Elec Rev, Lond—Nov. 15, 1901. No. 44609 A.

Lightning.

Tesla's Artificial Lightning. Harris J. Ryan. Photograph of a shower of electrical discharges produced, with remarks. 700 w. Sibley Jour of Engng—Nov., 1901. No. 44429 C.

Radiography.

A New Method of Obtaining Stereoscopic Effects in the Fluoroscope. Eugene W. Caldwell. Describes and illustrates improved systems for X-ray work by which stereoscopic X-ray vision may be obtained. 2000 w. Elec Rev, N. Y. —Nov. 16, 1901. No. 44360.

GENERATING STATIONS.

Alternators.

The Design and Construction of Alternators (La Construction et l'Etablissement des Alternateurs). A translation of the paper of M. Lasche recently presented before the *Verein Deutscher Ingenieure.* Serial. Part I. 1500 w. Revue Technique—Oct. 10, 1901. No. 44548 D.

The Hutin & Leblanc Compound Alternator (L'Alternateur Compound Système Hutin & Leblanc). A full detailed description of the large alternator exhibited at the Paris exposition. 2500 w. Revue Technique—Oct. 25, 1901. No. 44509 D.

Business Building.

Lighting and Heating in the Graham Court, New York. Illustrated description of the mechanical plant, including water-tube boilers, direct-connected electric units, electric elevators with a storage battery, and a special annunciator service, in an 8-story 170x200 ft. apartment house. 3500 w. Eng Rec—Nov. 2, 1901. No. 44149.

The Steam and Electrical Plant of the North American Building, Philadelphia. Description with plans of the plant for a twenty-one story office building. 6500 w. Eng Rec—Nov. 23, 1901. No. 44491.

Central Stations.

A Modern Small Central Station. W. H. Zimmerman. The plant of the Urbana (Ill.) Light, Heat and Power Company is illustrated and described. 1500 w. Am Elect'n—Oct., 1901. No. 44316.

Bringing Up to Date an Old-Style Central Station. Illustrates and describes the remodeled plant of the Georgia Electric Light Company. 3000 w. Am Elect'n—Oct., 1901. No. 44312.

Coal Handling.

Coal Handling Machinery in Central Stations. F. L. Hutchinson. Illustrated discriptions of arrangements used. 3200 w. Am Elect'n—Oct., 1901. No. 44318.

Dynamos.

Principles of Dynamo Construction. Presents principles essential to the design and construction of dynamos and motors, discussing each in detail. Ill. 3000 w. Elec, N. Y—Nov. 13, 1901. Serial. 1st part. No. 44282.

The Design of a 5-K. W. Dynamo. An illustrated detailed description of a design to be constructed with the ordinary tools and appliances found in any engineering workshop. 5000 w. Elec Engr, Lond—Nov. 15, 1901. No. 44612 A.

Generating Sets.

Final Report of Committee on Standardization of Engines and Dynamos. 2600 w. Trans Am Soc of Mech Engrs, No. 887—Dec., 1901. No. 44625.

Generators and Transformers for the Bay Counties Power Co., California. E. Heitmann and Wm. Currie. Illustrated description of the generating units and the step-up transformers, discussing the principal features to be considered in making the selection. 2500 w. Eng News—Nov. 21, 1901. No. 44475.

We supply copies of these articles. See page 649.

Should Dynamos Be Used as Fly Wheels? (Sollen Dynamos als Schwungräder Dienen?). A. Rothert. A review of the conditions under which the revolving portion of a generator may properly be used as a fly-wheel for the engine. 3000 w. Zeitschr d Ver Deutscher Ing—Oct. 26, 1901. No. 44515 D.

Hydro-Electric Plant.

The Saut Mortier Power Station on the River Ain. Notes from a description by J. Claudet in *Le Genie Civil*. Ill. 1700 w. Eng Rec—Nov. 16, 1901. No. 44406.

Parallel Running.

Parallel Operation of Engine-Driven Alternators. W. L. R. Emmet. Read at meeting of the Am. Inst. of Elec Engrs. Presents a method of overcoming the difficulties of such operation which has been in successful use for three years in many important installations. 2500 w. St Ry Jour—Nov. 2 1901. No. 44203 D.

Parallel Running of Alternators. Ernest J. Berg. Considers the principles governing the parallel operation of alternators driven by steam engines or turbines. 1200 w. Trans Am Inst of Elec Engrs—Oct., 1901. No. 44427 D.

The Design of Engines for Operating Alternators in Parallel. R. H. Rice. Read at the meeting of the Am. Inst. of Elec. Engrs. Discusses the determining of the proper fly-wheel effect, and the type of governor. 1000 w. St Ry Jour—Nov. 2, 1901. No. 44204 D.

The Parallel Running of Alternators (Parallelbetrieb in Wechselstromsystemen). H. S. Meyer. A mathematical examination of the principles of parallel running, with an exposition of its advantages. 3500 w. Elektrotech Zeitschr—Oct. 31, 1901. No. 44562 B.

Polyphase.

The Computation of Polyphase Generators (Zur Berechnung Mehrphasiger Generatoren). K. Pichelmayer. With a table of co-efficients and diagram of characteristic curves for use in designing. 1800 w. Elektrotech Zeitschr—Oct. 31, 1901. No. 44563 B.

Power Plant.

The New Plant of the Virginia Electrical Railway & Development Co., Richmond, Va. Illustrated description of a plant in which the generating units are direct connected both to the turbine shafts of a hydraulic plant and the main shafts of a plant with vertical steam engines. The character of the water power, the nature of the service and the structural features are explained. 4400 w. Eng Rec—Nov. 9, 1901. No. 44208.

The Steam and Electric Plant of a Graphite Factory. Illustrates and describes the plant of the Joseph Dixon Crucible Company. 1700 w. Am Elect'n—Nov., 1901. No. 44233.

Speed Regulation.

See Mechanical Engineering, Steam Engineering.

Transformer.

General Electric Company's Constant Current Transformer for Alternating Series Arc Lighting. Report on the invention of Prof. Elihu Thomson. Ill. 1700 w. Jour Fr Inst—Nov., 1901. No. 44,225 D.

Some Up-to-Date Transformers. W. E. Warrilow. Illustrates and describes recent designs showing the advances made. 3000 w. Elec Engr, Lond—Oct. 25, 1901. Serial. 1st part. No. 44124 A.

Transformers. A. S. M'Allister. Concerning the behavior of the transformer built according to modern practice. 3500 w. Am Elect'n—Oct., 1901. No. 44313.

LIGHTING.

Accounting.

Modern Electric Light Accounting. A S. Knight. Abstract of a paper read at the Buffalo meeting of the Assn of Edison Ill. Co.'s, describing the accounting system of the Boston Edison Company. 3300 w. Elec Wld & Engr—Nov 2, 1901. No. 44197.

Arc Lights.

Relative Merits of Open and Enclosed Arc Lights for Street Illumination. W. D'A. Ryan. Abstract of a paper read before the Ohio Elec. Lgt. Assn. Considers the peculiarities of different lamps, small vs. large units, etc. giving candle-power curves and curves showing street illumination. 1600 w. Am Elect'n—Nov., 1901. No. 44235.

Narragansett System.

The Narragansett Electric Lighting Company's System. An illustrated description of the installation that furnishes light and motive power for half the State of Rhode Island. 3800 w. Elec Rev, N. Y—Nov. 9, 1901. No. 44249.

Street Lighting.

Electric Street Lighting and Population. Alton D. Adams. An examination of the relation existing between the extent of population and the use of electric street lamps in the State of Massachusetts, the kinds of lamps used, etc. 2000 w. Elec Rev, N. Y.—Nov. 9, 1901. No. 44251.

United States.

The Electric Lighting Industry of the United States. A tabular statement of the present status of this industry, giving facts and figures hitherto unpublished. Also editorial. 2000 w. Elec Rev, N. Y—Nov. 9, 1901. No. 44250.

MEASUREMENT.

Compensation.

A New Form of the Thiermann Com-

pensator (Eine Neue Form des Thiermannschen Kompensators). P. Heyck. Describing an improved form of the Thiermann device for measuring currents by compensation. 2500 w. Elektrotech Zeitschr—Oct. 17, 1901. No. 44560 B.

Electric Meters.

Some Fundamentals of Electric Meters. Caryl D. Haskins. Discusses the relation between torque, friction, aging of various kinds, and local surroundings as affecting inter-accuracy. 2000 w. Trans Am Inst of Elec Engrs—Oct., 1901. No. 44422 D.

Electroscope.

A Method of Determining Very Small Electrical Charges (Sur une Methode Propre à Déceler de Très Petites Charges Electriques). R. Blondlot. A communication to the French Academy describing a very sensitive form of electroscope. 1200 w. Comptes Rendus—Nov. 4, 1901. No. 44547 D.

Energy Meters.

Metering of Electrical Energy. Harry P. Davis. Notes outlining some of the more important features which should be embodied in the ideal meter, with data and a brief description of a test on a meter largely used. 3500 w. Trans Am Inst of Elec Engrs—Oct., 1901. No. 44423 D.

Indicator.

The Construction of a Current and Potential Indicator. Sketches, with explanations, illustrating the essential features of a simple indicator which may be wound either to serve as a voltmeter or potential indicator, or as an ammeter or current indicator. 1200 w. Am Elect'n—Oct., 1901. No. 44319.

Lag.

Measurement of the Angle of Lag of Three-Phase Circuits with One Wattmeter. A. S. McAllister. Outlines the method. 700 w. Elec Wld & Engr—Nov. 23, 1901. No. 44627.

Power Factor.

A Means of Measurement of the Angle of Lag and the Power Factor with a Voltmeter. George T. Hanchett. Gives an interesting method of measuring the power factor of an alternating-current circuit, requiring no other instrument than the voltmeter. 800 w. Elec Wld & Engr—Nov. 2, 1901. No. 44196.

POWER APPLICATIONS.

Cranes.

Electric Traveling Crane for a Steel Foundry (Elektrisch Betriebener Laufkran für eine Stahlwerk-Giesshalle). A. Kolben. With details of the hoisting gear and scheme of the wiring for a 10-ton crane of 11 metres span. 3000 w. Zeitschr d Ver Deutscher Ing—Oct. 26, 1901. No. 44514 D.

Recent Electric Cranes (Neuere Elektrisch Betriebene Hebezeuge). Illustrated description of 100-ton electric wharf crane at Bremen. 1500 w. 1 plate. Zeitschr d Ver Deutscher Ing—No. 44,-518 D.

20-Ton Locomotive Steam Crane. Illustration with brief description of a powerful tool built in England for use in Mexico. 500 w. Engng—Nov. 8, 1901. No. 44340 A.

Electrical Industries.

Electricity in the Service of Man. A. N. Brady. Briefly reviews the many applications of electricity, and the large investments represented. 2400 w. N Am Rev—Nov., 1901. No. 44118 D.

Electrogravure.

An Electro-Mechanico-Chemical System of Die Sinking and Engraving. Describes a process for automatically cutting away steel surfaces in irregular and delicate shapes. Ill. 1400 w. Am Mach—Nov. 7, 1901. No. 44265.

Lathe Driving.

Electrically Driven Lathes (Tours Actionnés Electriquement). Ch. Dantin. Showing the application of electric driving to large lathes for turning crank shafts of marine engines. 1500 w. Génie Civil—Oct. 19, 1901. No. 44506 D.

Mining Plant.

The Application of Electric Power to Mining (Anwendungen der Elektrizität im Bergbau). R. Goetze. A general examination of the adaptation of electric power to mining, including pumping and hoisting. 5000 w. Glückauf—Oct. 19, 1901. No. 44551 B.

Oil Wells.

Electrical Engineering at Oil Wells. On the use of electrical facilities in connection with blasting. Ill. 1300 w. Min Rept—Nov. 14, 1901. No. 44401.

Power Plant.

Power Plant of the Rose Building, Cleveland. Illustrated detailed description of plant. All the machinery in the building is steam driven except the elevators. 4200 w. Engr, U S A—Nov. 1, 1901. No. 44168.

Railway Motors.

The Determination of the Capacity of Railway Motors (Die Berechnung der Motorleistung im Bahnbetrieb). M. Müller. Showing the limitations as to sparking and overheating of motors at maximum load, with methods of computing these limits. 4000 w. Elektrotech Zeitschr—Nov. 7, 1901. No. 44564 B.

Rock Drill.

Electric Solenoid Impact Rock Drill (Elektrische Solenoid-Stossbohrer für Härtes Gestein). E. Heubach. A review

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of early electrical rock drills and a description of the improved drill of the Union Elektricitäts Gesellschaft and its work in hard rock. Two articles. 5000 w. Zeitschr d Ver Deutscher Ing—Oct. 19, 26, 1901. No. 44512 each D.

Rubber Works.

The Power Plant of the Silvertown India-Rubber Works. An illustrated description of the latest extensions to the plant. The installation is as large as is often provided for a town of 50,000 inhabitants, and is interesting because of the diversity of uses to which the motors are put. 1400 w. Elec Rev, Lond—Nov. 15, 1901. No. 44611 A.

Shipbuilding Plant.

The Electrical Equipment of Messrs. Palmer's Shipbuilding Works. Illustrates and describes the recent electrical equipment of the shipbuilding and engine departments of these extensive works at Jarrow-on-Tyne. 5000 w. Engng—Nov. 1, 1901. No. 44305 A.

Silk Mill.

Power Plant of a Large Silk Mill. Illustrated description of the plant in a mill at Altoona, Pa. 3200 w. Engr, U S A—Nov. 15, 1901. No. 44342.

TRANSMISSION.

Conductors.

The Arrangement of Overhead Conductors (L'Etablissement des Canalisations Aériennes). A discussion upon the stresses and deflections for long spans. 7000 w. Bull Soc Int des Elec—Aug., Sept., Oct., 1901. No. 44545 G.

Controlling.

Efficiency of Multiple Voltage Control in Electric Power Transmission. Lehman B. Hoit. Calls attention to the several ways in which losses occur in the use of power electrically transmitted. Brief discussion. 4500 w. Jour Assn of Engng Socs—Sept., 1901. No. 44111 C.

Electrical Surges.

Surges in Transmission Circuits. A. E. Kennelly. Considers electrical oscillations in circuits containing inductance and capacity. 4500 w. Elec Wld & Engr—Nov. 23, 1901. No. 44626.

High Potential.

Theoretical Investigations of Some Oscillations of Extremely High Potential in Alternating High Potential Transmissions. Charles Proteus Steinmetz. Gives a series of investigations on the effect of the exponential term in the general equation of alternating currents. 4200 w. Trans Am Inst of Elec Engrs. Oct., 1901. No. 44424 D.

Long Span.

Some Further Details of the Carquinez Span. Illustrates and describes details relating to the mechanical features of the towers. 1200 w. Jour of Elec—Oct., 1901. No. 44359.

Output.

Electrical Incomes and Outputs per Ton of Coal. Alton D. Adams. Presents figures derived from the report of the Gas and Electric Light Commissioners of Massachusetts, considering information gained from the study. 2200 w. Elec Wld & Engr—Nov. 16, 1901. No. 44382.

Snoqualmie.

Aesthetics in, and Extensions of the Snoqualmie Transmission. Gives an illustrated description of the tower over the shaft crowning the elevator entrance to the subterranean works, and the new substations in Seattle and Tacoma. Also describes the extension to be carried out. 3400 w. Jour of Elec—Oct., 1901. No. 44358.

MISCELLANY.

Address.

Inaugural Address by C. H. Wordingham before the Manchester Section of the Institution of Electrical Engineers. Describes technical questions of interest to the practical engineer in relation to electrical engineering. 4000 w. Elec Engr, Lond—Nov. 22, 1901. Serial. 1st part. No. 44723 A.

Mr. W. E. Langdon's Presidential Address to the Institution of Electrical Engineers. A review of electrical achievements from the standpoint of a railway engineer, and a discussion of the future prospects. 5000 w. Elect'n, Lond—Nov. 22, 1901. Serial. 1st part. No. 44718 A.

Electrical Engineering.

The Debt of Electrical Engineering to C. E. L. Brown. B. A. Behrend. The first of several articles giving an account of the work of a great engineer, and also showing the origin of many of the standard types of electrical apparatus. 3000 w. Elec Wld & Engr—Nov. 16, 1901. Serial. 1st part. No. 44380.

Modern Theories.

Outline of Modern Theories of Electricity and Magnetism. Harold B. Smith. Briefly outlines the theories and hypotheses and recent discoveries in electrical phenomena. 4000 w. Jour Worcester Poly Inst—Nov., 1901. No. 44119 C.

Report.

Report of the Commission of the Société Internationale des Electriciens to the Convention of the American Institute of Electrical Engineers (Rapport sur la Mission Envoyé par la Société Internationale des Electriciens au Congrés de l' American Institute of Electrical Engineers). 20,000 w. Bull Soc Int des Elec—Aug., Sept., Oct., 1901. No. 44544 G.

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GAS WORKS ENGINEERING

Acetylene.

Acetylene Gas. Harry C. Earle. On the progress as an illuminant, the claims made, the principle of the generators, &c. 1400 w. Sibley Jour of Engng—Nov, 1901. No. 44428 C.

Acetylene Gas in Germany and Sweden. Reports on the uses of acetylene in the countries named. 1200 w. U S Cons Repts—Oct. 31, 1901. No. 44072 D.

Calorimetry.

On the Determination of the Heat of Dissociation and of Combustion of Acetylene, Ethylene, and Methane. W. G. Mixter. An account of experimental investigations made at the Sheffield Laboratory of Yale University. 3000 w. Am Jour of Sci—Nov., 1901. No. 44114 D.

Coal Gas.

Mr. W. Foulis on the Economical Production and Utilization of Coal Gas. From the inaugural address before the Inst. of Engrs. & Shipbuilders of Scotland. Considers the question of the economical production of gas from coal, and its utilization. 6000 w. Jour Gas Lgt—Nov. 5, 1901. No. 44299 A.

Coke-Oven Gas.

The Production of Illuminating Gas from Coke-Ovens. The reply of Dr. F. Schniewind to the discussion on his paper at the Glasgow Gas Congress. 3300 w. Jour Gas Lgt—Nov. 12, 1901. No. 44601 A.

Extensions.

Extensions at the Nechells and Saltley Gas Works, Birmingham, Eng. Henry Hack. Illustrated notes describing the extensions made since 1898. 8500 w. Gas Wld—Oct. 26, 1901. No. 44129 A.

Gasholders.

An Intze Gasholder Tank. Extract from the specifications for an improved gasholder, by Otto Intze. Describes a new construction of annular metal gasholder tank, giving drawings. 1500 w. Gas Wld—Nov. 9, 1901. No. 44328 A.

Intze Gasholders and Tanks. An abstract of the patent specification, with illustrations. 2000 w. Jour Gas Lgt—Nov. 12, 1901. No. 44602 A.

High Pressure.

Notes on High Pressure Gas Lighting. A. W. Onslow. Referring to means of securing a large amount of light from one burner. Discussion. 4200 w. Gas Wld —Nov. 16, 1901. No. 44608 A.

Light Distribution.

The Distribution of Gas Light in Space and the Technical Application of Milk-Glass. Dr. O. Schott and Dr. M. Herschkowitsch. Summary from the *Journal für Gasbeleuchtung*. Gives curves showing how the light is distributed, and discusses the effect of diffusing glass. 1000 w. Gas Wld—Nov. 9, 1901. No. 44327 A.

Management.

What Is the Business of a Gas Company? Frank D. Moses. Read at meeting of the Am. Gas Lgt. Assn. Considers ways to increase the sale of gas. Also discussion. 4500 w. Pro Age—Nov. 15, 1901. No. 44344.

Modern Practice.

Modern Practice in the Manufacture and Distribution of Gas. Harry Edward Jones. Begins the publication of an interesting paper presented to the Inst. of Civ. Engs., with a report of the discussion upon it. 4000 w. Gas Wld—Nov. 9, 1901. Serial. 1st part. No. 44326 A.

Naphthalene.

Further Experiences with Reversible Condensers. Charles Carpenter. Read before the So. Dist. Assn. of Gas Engrs & Mgrs. Explains the writer's successful method of abolishing the naphthalene trouble. Ill. 2000 w. Gas Wld—Nov. 16, 1901. No. 44606 A.

Natural Gas.

Natural Gas Production. F. H. Oliphant. Reviews the gas-producing areas of the United States, giving information related. 4500 w. Am Mfr—Nov. 7, 1901. No. 44223.

Power Gas.

See Mechanical Engineering. Power and Transmission.

Prepayment Meters.

Some Considerations Respecting the Slot Metre System and the Suggestion of a Hire-Purchase System for Fittings, &c., as an alternative. George Helps. Discusses what should be expected of the slot system, the objections, an alternative system and its advantages. 5500 w. Gas Wld—Nov. 2, 1901. No. 44294 A.

Residuals.

The Fuel Value of Residuals. Charles F. Prichard. Read before the Am. Gas Lgt. Assn. Gives ultimate analyses of residuals which have fuel values, their fuel values based on these analyses, their fuel values tested by calorimeter, and their fuel value obtained by burning large quantities of them and the methods employed. 3700 w. Am Gas Lgt Jour—Nov. 18, 1901. No. 44402.

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Retort Ovens.

Retort Ovens as Producers of Illuminating Gas. T. Littlehales. Read at meeting of the Am. Gas. Lgt. Assn. An extended discussion of this subject concluding that in gas works of even moderate size, operating with retort ovens, and turning out first-class foundry coke, good profits can be made with gas at prices impossible for retort methods to compete with. Ill. 7500 w. Am Gas Lgt Jour—Nov. 11, 1901. No. 44269.

Retort Ovens as Producers of Illuminating Gas. Discussion of Mr. Thomas Littlehale's paper. 2000 w. Am Gas Lgt Jour—Nov. 25, 1901. No. 44628.

Retorts.

The Construction and Method of Charging Inclined Retorts. Gilbert Little. Relating to improvements for reducing cost and improving quality of machinery. Ill. 1700 w. Jour Gas Lgt—Oct. 22, 1901. No. 44105 A.

The Economical Advantages of Inclined Retort-Settings. W. R. Herring. A discussion of this subject, referring to a former paper, and to the views of others, and considering the automatic discharging of inclined retorts. 2800 w. Jour Gas Lgt —Nov. 5, 1901. No. 44298 A.

Special Work.

Experiences Encountered During the Alterations to Connections of an 80-Foot Diameter Water Gas Relief Holder and Tank. T. Randolph Murray. Read before the So. Dist. Assn. of Gas Engrs. & Mgrs. An account of a somewhat difficult piece of work. A gasholder tank was emptied while the holder was kept in work almost up to the last moment. 6000 w. Gas Wld—Nov. 16, 1901. No. 44607 A.

Standards.

A Comparison of Standards for Cast Iron Pipe and Specials. Walton Forstall. Read before the Am. Gas Lgt. Assn. Discusses the differences between the standards of the Association and those now in use by the United States Gas Improvement Company. 3500 w. Am Gas Lgt Jour—Nov. 25, 1901. No. 44629.

Vienna.

The Vienna Municipal Gas-Works. An illustrated description prepared mainly from a brochure issued at the meeting of the gas and water engineers last June. 2600 w. Jour. Gas Lgt—Nov. 12, 1901. Serial. 1st part. No. 44600 A.

Water Gas.

Early Plant for Making Water Gas. An illustrated account of an apparatus constructed in France in 1819, by Philippe Gengembre and his son, Antoine. 1200 w. Jour Gas Lgt—Nov. 12, 1901. No. 44603A.

Tar and Water from Water Gas. W. E. McKay. Read before the Am. Gas Assn. Tabulated data showing the changes in the manufacture of gas and in the sales of residuals, in Massachusetts, during the past 14 years, with description of system of separation used, and other information. 11700 w. Am Gas Lgt Jour—Nov. 4, 1901. No. 44106.

INDUSTRIAL ECONOMICS

Coal Exports.

The Growth of American Coal Exports. F. E. Saward. A study of the increasing exports of American coal, showing how this cheap source of fuel supply will promote European industries. 3500 w. Engineering Magazine—Dec. 1901. No. 44571 B.

Competition.

The Manufacturers' View. Discusses some of the principal reasons for the loss of British trade, from the standpoint of the manufacturer of structural materials. 9300 w. Engr, Lond—Nov. 8, 1901. Serial. 1st part. No. 44335 A.

Cost Keeping.

The Proper Distribution of the Factory Expense Burden. A. Hamilton Church. In his sixth, and closing paper, Mr. Church discusses the proper apportionment of office and selling expense, and also makes a summary of the whole series of articles. 4000 w. Engineering Magazine—Dec., 1901. No. 44574 B.

Germany.

Commerce and Industries of Germany in 1900. A full discussion of conditions in Germany, the imports and exports, the various industries, American competition, tariff revision, &c. 5700 w. U S Cons Repts, No. 1185—Nov. 9, 1901. No. 44192 D.

Improvements.

Economics of Railway Improvements. W. W. Colpitts. From a paper read before the Canadian Soc. of Civ. Engrs. Discusses mistakes made in railway engineering, and the various improvements that make for economy of operation. 4700 w. Ry & Engng Rev—Nov. 23, 1901. Serial. 1st part. No. 44631.

Trade-Unionism.

Trade Unionism in Coal-Mining. The first of a series of articles discussing the recent growth of the system in Great Britain. 2000 w. Ir & Coal Trds Rev—Nov. 22, 1901. Serial. 1st part. No. 44735 A.

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MARINE AND NAVAL ENGINEERING

Armor.

Recent Experiments in Attacking Armor with High Explosive Shell. E. B. Babbitt. An account of the investigations of the Board of Ordnance and Fortification, the tests made and results. 4000 w. Soc Nav Archts & Marine Engrs, No. 10—Nov., 1901. No. 44440 C.

Balancing.

The Theoretical and Practical Methods of Balancing Marine Engines. D. W. Taylor. Description and demonstration of methods for the determination of unbalanced forces and moments of unbalanced couples in a known engine, and of balancing engines so as to reduce or extinguish unbalanced forces. Ill. 17000 w. Soc Nav Archts & Marine Engrs—Nov., 1901. No. 44438 D.

The Theoretical and Practical Methods of Balancing Marine Engines. Rear Admiral George W. Melville. A discussion of the various methods proposed or actually tried, giving their merits and demerits, and especially describing the MacAlpine system, which the writer believes to be the best. Ill. 15000 w. Soc Nav Archts & Marine Engrs—Nov., 1901. No. 44436 D.

Battleships.

A Brief Comparison of Recent Battleship Design. H. G. Gillmor. Compares the most recent designs of the several principal naval powers, in regard to armament, protection, speed, and coal supply. 3800 w. Soc Nav Archts & Marine Engrs, No. 7—Nov., 1901. No. 44437 C.

French First-Class Battleship "Charlemagne." Illustration and description of this French battleship and the novel method of mounting the main battery. 1100 w. Sci Am—Nov. 16, 1901. No. 44366.

Cobra.

The Cobra Disaster. Reviews the circumstances of the disaster and the judgment of the court-martial. 3500 w. Engr, Lond—Oct. 25, 1901. No. 44135 A.

Cruiser.

H. M. Armored Cruiser "King Alfred." Illustrated description of one of four vessels building for the British navy, and its equipment. 1200 w. Engng—Nov. 1, 1901. No. 44306 A.

The French Cruiser Jurien de la Gravière. Illustration, and a comparison with the British vessel "Hyacinth." 1000 w. Engr, Lond—Nov. 15, 1901. No. 44621 A.

Ferryboat.

New Steel Ferryboat. Illustration, with description of the Cape May, the latest addition to the fleet on the Delaware. 2000 w. Naut Gaz—Nov. 2, 1901. No. 44470.

Gunnery.

Naval Gunnery. S. Eardley-Wilmot. Discusses the lack of attention in the British Navy, to securing gun efficiency and the importance of drill and constant training. 2000 w. Engr, Lond—Nov. 1, 1901. No. 44308 A.

Inspection.

The United States Inspection Service. James A. Dumont. Gives a comparative statement of the work of the service for the year 1871 and 1900 inclusive, discussing the sinking of the Staten Island ferryboat Northfield, and other matters. 3800 w. Naut Gaz—Oct. 31, 1901. No. 44091.

Launching.

Side Launch of Torpedo-Boats and Torpedo-Boat Destroyers. W. G. Groesbeck. Describes the launching of torpedo-boats Shubrick, Stockton and Thornton, and of torpedo-boat destroyers Dale and Decatur launched sideways because of the limited extent of land and water available. Ill. 2500 w. Soc Nav Archts & Marine Engrs, No. 12—Nov., 1901. No. 44442 C.

Launch Motor.

Design for a 3 H. P. Launch Motor. Cecil P. Poole. Sketches showing the important features of a multipolar motor designed for driving the screw propeller of a pleasure boat, with description. 1500 w. Am Elect'n—Nov., 1901. No. 44238.

Merchant Marine.

Restoration of the American Merchant Marine. Richard P. Joy. Reviews the early history and the present position, and urges the taking of such measures as will restore the country's flag to its former glory on the seas. 2500 w. Marine Rev—Nov. 14, 1901. No. 44357.

Naval Warfare.

Naval Fashions. Archibald S. Hurd. Discusses the experiments in the construction of war vessels. 4900 w. Nineteenth Cent—Nov., 1901. No. 44321 D.

Navy Yard.

The Puget Sound Navy Yard. A. B. Wyckoff. An illustrated article explaining the natural advantages and the present development. 1400 w. Sci Am—Nov. 23, 1901. No. 44468.

Ordnance.

Late Developments in Ordnance and Armor. J. F. Meigs. Reviews the advances made during the last ten years.

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6000 w. Soc Nav Archts & Marine Engrs, No. 9—Nov., 1901. No. 44439 C.

Important competitive Test of High Explosive Shells at Sandy Hook. Illustrated description of very important trials with discussion of the results. Also editorial. 3000 w. Sci Am—Nov. 30, 1901. No. 44649.

Organization.

Organization of the Engineer Division on Board a Man-of-War. C. W. Dyson. Gives the writer's ideas as to the proper organization. Also general discussion. 8000 w. Jour Am Soc of Nav Engrs—Nov., 1901. No. 44640 H.

Police Launch.

Design of German Police Launch Built at Howaldtswerke, Kiel, Germany. George Crouse Cook. An illustrated description of a high-powered steam launch. 1200 w. Marine Engng—Nov., 1901. No. 44259 C.

Propeller Shaft.

Installing a Propeller Shaft Without Docking. H. Webster. Illustrated account of the method used in the torpedo-boat "Shubrick." The stern of the vessel was raised and the work carried on from floats. 800 w. Marine Engng—Nov., 1901. No. 44261 C.

Propellers.

Propeller Design. Theodore Lucas. An illustrated discussion of the important factors. 1400 w. Naut Gaz—Nov. 7, 1901. No. 44252.

Salvage.

A Novel Salvage Operation. Waldon Fawcett. Illustrates and describes the raising of the Columbia River lightship from the sands on the beach on the N. Pacific Coast, and the removal of the vessel overland to the waters of Baker's Bay. 1600 w. Sci Am—Nov. 16, 1901. No. 44364.

Shaft Breakages.

Causes of Breakage of Propeller Shafts. Discusses the causes of failure under poor material, unforeseen straining and corrosion. Ill. 2300 w. Marine Engng—Nov., 1901. No. 44257 C.

Shipbuilding.

The New Machine Shop and Power House at the Cramp Shipyard. An illustrated description of the recent improvements made which nearly doubles the capacity of this plant. 800 w. Naut Gaz —Nov. 7, 1901. No. 44253.

Shipping.

The End of Prosperity for the Ship Owner. Editorial discussion of the changes during recent years and the present situation. 1300 w. Eng News—Nov. 7, 1901. No. 44278.

Speed Trial.

Trial of Speed Between the Steamers City of Erie and Tashmoo. Frank E. Kirby. Illustrations with descriptions of steamers and an account of the trial on Lake Erie on June 4, 1901. 1300 w. Soc Nav Archts & Marine Engrs, No. 1—Nov., 1901. No. 44433 C.

Steamer.

Passenger Steamer Puritan. Illustrated detailed description of a steamer for the Great Lakes to ply between Holland, Mich., and Chicago. 1300 w. Marine Engng—Nov., 1901. No. 44258 C.

Steamship Construction.

A Graphical Record of Progress in Steamship Construction. Chart prepared by Herr Otto Schlick showing typical steam vessels from the beginning of steam navigation to the present time all drawn to the same scale. Brief descriptions are given. 1000 w. Eng News—Nov. 14, 1901. No. 44391.

Steamship.

Express Steamship Kronprinz Wilhelm. Brief illustrated description of this new liner for the North German Lloyd Co. 1500 w. Marine Engng—Nov., 1901. No. 44256 C.

Fine Coasting Steamship. Illustration, with brief description of the Denver, a fine vessel of the Mallory line. 1000 w. Naut Gaz—Oct. 31, 1901. No. 44090.

Stresses.

The Effect of Variation of Dimensions upon the Stresses in a Ship's Structure. Herbert C. Sadler. Discusses this subject, considering the forces which tend to strain the vessel as a whole, and those which tend to strain it locally. Plates. 4400 w. Soc Nav Archts & Marine Engrs, No. 2—Nov., 1901. No. 44434 C.

Tidal Corrections.

Some Notes on Tidal Corrections. Edwin A. Stevens. Tidal calculations made on progressive trial runs, with methods used. 1500 w. Soc Nav Archts & Marine Engrs, No. 11—Nov., 1901. No. 44441 C.

Torpedoes.

Power Consumed in Propelling the Whitehead Torpedo at Various Speeds. Frank M. Leavitt. An account of tests made to ascertain the efficiency of the motive power, and the amount of power required to drive the torpedo at various speeds up to thirty-three knots per hour. Ill. 4400 w. Soc Nav Archts & Marine Engrs, No. 4—Nov., 1901. No. 44435 C.

Wastage.

Wastage of the Navies. A long list of disasters showing that storms do much more damage than wars. 1800. Marine Rev—Nov. 7, 1901. No. 44227.

We supply copies of these articles. See page 649.

MECHANICAL ENGINEERING

AUTOMOBILES.

Alcohol Motors.

Alcohol Motor Car Trials in France. Concerning the trials being carried out by the Minister of Agriculture to open a source of consumption for alcohol. Ill. 3200 w. Engr, Lond—Nov. 8, 1901. No. 44336 A.

The French Alcohol Carriage Trials. Brief account of trials in the neighborhood of Paris for obtaining official data upon the economy of alcohol, and its utilization. Ill. 1500 w. Autocar—Nov. 9, 1901 No. 44325 A.

Bakery Vehicle.

A Military Bakery Automobile. An illustrated description of a flour mill and bakery automobile designed to follow regiments and make fresh bread every hour from wheat obtained by requisition. 500 w. Sci Am Sup—Nov. 16, 1901. No. 44371.

Boiler Test.

Test of Capacity and Economy of Boiler of a Motor Carriage. Charles D. Chasteney. Abstract from graduation thesis describing a test made to determine the horse-power and general performance of the boiler. 1400 w. Stevens Ind—Oct., 1901. No. 44081 D.

British Car.

A New British Autocar. Illustrated description of a new design. 800 w. Autocar—Nov. 16, 1901. No. 44604 A.

Diagram.

Diagram for Motor Vehicle Problems. P. S. Bushnell. Chart for quickly solving calculations arising in motor vehicle design, with explanation. 500 w. Am Mach—Nov. 14, 1901. No. 44352.

Graphical Representation of the Cycles of Petroleum Motors (Représentation Graphique du Cycle des Moteurs à Pétrole). L. Nerdeux. Showing the application of the Zeuner diagram to internal combustion motors. 1500 w. Revue de Mécanique—Oct. 31, 1901. No. 44535 E + F.

Duryea Vehicles.

A Chapter of History and an Interesting Car. An account of the struggle for success with an illustrated description of vehicles. 2000 w. Autocar—Nov. 16, 1901. No. 44605 A.

Electric Vehicles.

Some Electric Vehicles at the Show. P. M. Heldt. Comments on the exhibits at the recent Automobile show at Madison Sq. Garden, N. Y. 900 w. Horseless Age—Nov. 6, 1901. No. 44248.

Exhibition.

Some Exhibits at the Automobile Show. Illustrations and descriptions of vehicles at the second annual Automobile show at Madison Sq. Garden, N. Y. 1500 w. Sci Am—Nov. 16, 1901. No. 44370.

The Automobile Show. An illustrated account of the recent annual exhibition held at Madison Square Garden, New York. 2700 w. Auto Mag—Dec., 1901. No. 44632 C.

Experience.

Commonplace Automobile Experience. An account of troubles of various sorts, and some of the causes. 2200 w. Horseless Age—Nov. 6, 1901. No. 44245.

Practical Automobile Experience. Dr. Charles H. Lemar. Gives facts from a physician's experience, not very encouraging for doctors of moderate incomes. 1200 w. Horseless Age—Nov. 6, 1901. No. 44244.

Some Automobile Experience by a Country Physician. Willets P. Haines. Gives experience with gasoline and steam vehicles. 2000 w. Horseless Age—Nov. 6, 1901. No. 44243.

Two Years' Experience with Two Gasoline Wagons. Dr. George P. Jesup. An account of things learned, cost, &c. Considers the automobile an ideal but rather expensive conveyance. 1500 w. Horseless Age—Nov. 6, 1901. No. 44242.

Fire Engines.

Modern German Fire Engines. Illustrated description of motor fire-engines of various types. 700 w. Sci Am Sup—Nov. 16, 1901. No. 44372.

Gasoline Exhibits.

The New Gasoline Exhibits. Albert L. Clough. Brief illustrated descriptions of recent carriages. 2200 w. Horseless Age—Nov. 6, 1901. Serial. 1st part. No. 44247.

Gasoline Vehicles.

A Year's Development in the Gasoline Class. Perry B. Rawson. Reviews the exhibits at the recent exhibition at Madison Sq. Garden, New York. 3000 w. Horseless Age—Nov. 13, 1901. No. 44355.

Late Practice in Gasoline Vehicles as Indicated by the Show. Albert L. Clough. Discusses speed, prices, tires, driving chains, ignition, lubrication, steering, and brakes. 2500 w. Horseless Age—Nov. 13, 1901. No. 44356.

Light Cars.

The Latest De Dion-Bouton Vehicles. An illustrated detailed description of a

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new light car with the motor placed in front under a bonnet. The mechanism is fully explained. 3000 w. Autocar—Nov. 9, 1901. Serial. 1st part. No. 44324 A.

Military Tractors.

Competition of Military Motor Tractors Instituted by the British War Office. Gives the rules that are to govern the competition. 1800 w. Horseless Age—Nov. 20, 1901. No. 44455.

Motor Bicycles.

The Future of the Motor Bicycle. J. Lewis Strahan claims that an efficient reliable motor is now available, and calls attention to points in the design of the frames of bicycles that need correcting. 1700 w. Horseless Age—Nov. 6, 1901. No. 44241.

Motor Suspension.

Suspension of Gasoline Motors. Hugh D. Meier. Criticises present practice and suggests improvements that will permit the use of tires having a longer lease of life. 900 w. Horseless Age—Nov. 6, 1901. No. 44240.

Novelties.

Some Novelties in Vehicles and Accessories. Harry E. Dey. An illustrated article calling attention to recent designs and inventions. 2000 w. Horseless Age—Nov. 13, 1901. No. 44354.

Petroleum Vehicle.

The Development of the Petroleum Automobile. Paul Daimler. A review of the life and work of Gottlieb Daimler, the "Father of the Automobile," and an account of the development of the Daimler motor vehicles. 2500 w. Engineering Magazine—Dec., 1901. No. 44573 B.

Quarry Transport.

Heavy Motor Vehicles for Quarry Transport. Discusses the economy of this kind of transport, and gives illustrated descriptions of the various forms of wagons that promise to be of service. 5000 w. Quarry—Nov. 1, 1901. Serial. 1st part. No. 44291 A.

Steam Truck.

The Toledo Four-Ton Steam Truck. Illustrated description of a vehicle for heavy duty which has given good results. 1100 w. Horseless Age—Nov. 20, 1901. No. 44454.

Steam Vehicles.

Steam Vehicles at the Automobile Show. Jos. W. Jones. The present article comments on the Lane automobile, the Morgan water-tube boiler, and other exhibits. Ill. 1200 w. Horseless Age—Nov. 6, 1901. Serial. 1st part. No. 44246.

Style.

Style in Automobiles. Hrolf Wisby. An illustrated article discussing the style developing in the racing automobile and critising the lack of style in most other motor vehicles. 1500 w. Sci Am—Nov. 9, 1901. No. 44228.

HYDRAULICS.

Mine Pumping.

See Mining and Metallurgy, Mining.

Plumbing.

Water Supply in a Block of New York Tenements. Illustrated description of the work done in tenements designed for very low rental, yet providing far better sanitary surroundings than usual. 1600 w. Eng Rec—Nov. 2, 1901. No. 44150.

Pumping Engines.

Duty Trials of Four Holly Pumping Engines, Metropolitan Water-Works. Slightly condensed official report of the duty trials of three 35,000,000-gallon pumping engines at Chestnut Hill, and one 20,000,000-gallon engine at Spot Pond. Ill. 3800 w. Eng Rec—Nov. 16, 1901. No. 44408.

Pumping Engines at Hampton. Two-page supplement and drawings of details with description. 2500 w. Engr, Lond—Nov. 1, 1901. No. 44310 A.

Tests of High-Duty Holly Pumping Engines for the Boston Water Supply. An illustrated description of the plant with report of tests. 4000 w. Eng News—Nov. 14, 1901. No. 44394.

Pumps.

The Suction of Pumps (Die Vorgänge beim Ansaugen der Pumpen). H. Hagens. Discussing especially the suction action of high-speed pumps and the influence of air chambers. 3500 w. Zeitschr d Ver Deutschr Ing—Oct. 26, 1901. No. 44516 D.

Turbines.

Italian Turbines for a Niagara Water-Power Plant. Illustrates and describes the turbines supplying power to the plant of the Hamilton Electric Light & Cataract Power Co. 900 w. Eng News—Nov. 14, 1901. No. 44390.

The Construction of the Buckets of Radial Turbines (Zur Konstruktion der Laufräder Radialturbinen). N. Baashuus. A graphical method of laying out the curves of the buckets of wheels of the Francis type. 2000 w. Zeitschr d Ver Deutscher Ing—Nov. 9, 1901. No. 44523 D.

The New Turbines for the Niagara Falls Power Company. Illustrated description with a statement of the conditions to be met. 700 w. Eng Rec—Nov. 23, 1901. No. 44496.

Water Power.

A Project for Developing the Water Power of the Des Moines Rapids. Reviews the report of Lyman E. Cooley in the general engineering aspects of the enterprise, its construction and cost. 5600 w. Eng News—Nov. 14, 1901. No. 44395.

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MACHINE WORKS AND FOUNDRIES.

Bicycle-Spokes.

Bicycle-Spoke-Making Machinery. Illustrates and describes a set of ingenious automatic machines for stretching, straightening, cutting, screwing, heading and bending. 1700 w. Engr, Lond—Nov. 15, 1901. No. 44622 A.

Castings.

Three Fixtures for Machining a Special Casting. William Doran. Illustrates and describes fixtures for machining a cast-iron bracket. 1200 w. Am Mach—Nov. 21, 1901. No. 44459.

Connecting Rods.

Making Steam Engine Connecting Rods on the Milling Machine. Charles S. Gingrich. Describes an experiment showing the wide applicability of the milling machine. 1300 w. Am Mach—Nov. 21, 1901. No. 44457.

Contraction.

Controlling the Contraction of Metals While Casting. William D. Allen. Abstract of a paper read before the Foundrymen's Assn. of Phila. Illustrates and describes the process. 1200 w. Ir Age—Nov. 14, 1901. No. 44346.

Cost Keeping.

See Industrial Economics.

Crane Hooks.

Crane Hooks. A. E. Holcomb. Table and formulas with directions for use. 400 w. Am Mach—Oct. 31, 1901. No. 44087.

Cranes.

See Electrical Engineering, Power Applications.

Cupolas.

The Foundry Cupola, and How to Manage it. Robert Buchanan. Abstract of a paper read at Dudley meeting of the Staffordshire Iron & Steel Inst. Discusses the designs in use, the blast pressure, and scaffolding, in the present number. 3000 w. Ir & Coal Trds Rev—Nov. 8, 1901. Serial. 1st part. No. 44333 A.

Dies.

A Gang Die and Its Work. William Doran. Illustrated description of a punch and die adapted for the production of a variety of pierced and formed articles. 1000 w. Am Mach—Oct. 31, 1901. No. 44088.

A Small Blanking, Drawing and Bending Die. Describes a tool with a base of only 2½x2 inches which performs three distinct operations—blanking, drawing and bending. Ill. 1200 w. Am Mach—Nov. 14, 1901. No. 44350.

Elevators.

A Graphical Method of Laying Out the Corner of an Elevator Car. F. B. Kleinhaus. Illustrates and describes the method. 500 w. Am Mach—Nov. 14, 1901. No. 44349.

Engine Design.

The Design of Engines of Varying Powers from One Set of Drawings. Prof. H. C. Sadler. Considers the principal conditions which influence the power developed by an engine, and those that govern the sizes of the different parts; then shows a larger or smaller power may be designed from the same drawings. 2000 w. Marine Engng—Nov., 1901. Serial. 1st part. No. 44260 C.

Engine Manufacture.

Some Factors Affecting the Economical Manufacture of Steam Engines. William Thompson. Read at the Glasgow Congress. The points discussed are the premium system, tools, arrangement of tools, shops, standardization, &c. 3500 w. Engs' Gaz—Nov., 1901. No. 44293 A.

Factory Engines.

Steel Forgings for Factory Engines. H. F. J. Porter. Abstract of a paper presented at the 1891 fall meeting of the New England Cotton Mfrs. Assn. Relates the difficulties that presented themselves when this metal was first put to this use, the final success, and the merits of the steel shaft, giving the stand and specifications adopted. Ill. 4500 w. Power—Nov., 1901. No. 44094.

Flanges.

An Emergency Flange. Illustrates and describes an invention for providing a ready means for making good a faulty or broken joint, or fractured pipe in case of emergency, applicable for steam, water, compressed air, or gas mains. 1000 w Col Guard—Nov. 8, 1901. No. 44334 A.

Fly-Wheels.

The Bursting of Small Cast-Iron Fly-Wheels. Charles H. Benjamin. A series of experiments and description of the new apparatus used and the results. Gives conclusions drawn. Ill. 2500 w. Trans Am Soc of Mech Engrs, No. 916—Dec., 1901. No. 44444.

Foundry.

The Relation of the Foundry to Engineering Works. Walter J. May. Considers it an important factor in the economical arrangement of work. 1200 w. Prac Engr—Nov. 1, 1901. No. 44285 A.

What the Engineer Has Done for the Foundry. R. Moldenke. Reviews the improvements introduced in foundry work, giving brief sketches of well known workers in this industry. 2200 w. Ir Trd Rev—Nov. 14, 1901. No. 44378.

Jigs.

A Drill Jig and Its Excellent Work. W. H. Pike, Jr. Illustrated description of a jig which has proved of value in producing work in which great accuracy is re-

quired. 500 w. Am Mach—Nov. 21, 1901. No. 44460.

Lathe Driving.

See Electrical Engineering, Power Applications.

Machine Design.

A Weak Point in Machine Design (Eine Stelle an Manchen Maschinenteilen deren Beanspruchung auf grund der Ueblichen Berechnung Stark Unterschätzt Wird). C. Bach. An examination of the weakness of internal angles in machine castings. 2000 w. Zeitschr d Ver Deutscher Ing—Nov. 2, 1901. No. 44519 D.

Machine Tools.

A Swedish Miller and Gear Cutter, Boring Machine and Variable Speed Countershaft. Illustrated description. 900 w. Am Mach—Nov. 7, 1901. No. 44266.

Some Examples of the Evolution in Machine Tool Practice. Robert I. Clegg. Reviews the development of the machine shop industry, giving illustrated descriptions of labor-saving machines introduced, and discussing methods adopted in advanced practice. 7500 w. Ir & Trd Rev—Nov. 14, 1901. No. 44379.

The Development of Machine-Tool Building in Germany (Aufgaben und Fortschritte des Deutschen Werkzeugmaschinenbaues). F. Ruppert. An examination of machine details with especial reference to the modifications due to American practice. Serial. Part I. 3000 w. Zeitschr d Ver Deutscher Ing—Nov. 9, 1901. No. 44522 D.

Molding.

Molding Land Rollers. George Buchanan. The method of molding cylinder rollers is illustrated and described. 600 w. Am Mach—Nov. 14, 1901. No. 44351.

Molding Machine.

Bryan Vacuum Molding Machine. H. M. Baldwin. Brief description of the machine and its operation. 1600 w. Ir Age —Nov. 14, 1901. No. 44347.

New Works.

New Offices and Works of the Union Switch & Signal Co. Illustrated detailed description. 1500 w. Ry & Engng Rev —Nov. 9, 1901. No. 44271.

The Works of the Stanley Electric Manufacturing Company. Illustrates and describes the buildings and equipment of a new plant at Pittsfield, Massachusetts. 2200 w. Elec Rev, N. Y—Nov. 2, 1901. No. 44166.

Ornamental Work.

Blanking and Forming a Fancy Shell. Joseph V. Woodworth. Illustrates and describes the method of making, and dies used. 1200 w. Am Mach—Nov. 7, 1901. No. 44264.

Saw Guard.

Improved Safety Guard for Circular Saws (Nouveaux Chapeaux de Surété pour Scies Circulaires). H. Mamy. Illustrating an improved guard which rises to admit the work and closes after it. 1500 w. Génie Civil—Nov. 2, 1901. No. 44504 D.

Shop Labor.

A Bonus System of Rewarding Labor. H. L. Gantt. Describes a system of task work, with instruction cards and a bonus, used in the machine shop of the Bethlehem Steel Co. 6000 w. Trans Am Inst of Mech Engrs, No. 924—Dec., 1901. No. 44448.

Tools.

Some New Machine Tools. Illustrates and describes a cold saw for crank shafts, a six-spindle drill, a two-spindle boring machine, a reaming machine, and a gear cutter. 1000 w. Am Mach—Nov. 7, 1901. No. 44263.

Various Tools and Fixtures. A. H. Cleaves. Brief illustrated descriptions of a jack block, adjustable gage, clamp parts, squaring block, rod-drilling jig, square for planer, &c., &c. 1600 w. Am Mach—Nov. 7, 1901. No. 44262.

Workshop Methods.

Advanced Methods in a British Engineering Workshop. A. Lazenby. A fully illustrated account of the Victoria Works of Willans & Robinson, at Rugby, describing the installation and organization of the establishment, as well as the methods of work. 3500 w. Engineering Magazine—Dec., 1901. No. 44575 B.

MATERIALS OF CONSTRUCTION.

Alloys.

A Study of Copper-Aluminum Alloys (Contribution à l'Etude des Alliages Cuivre-Aluminum). L. Guillet. A comparison of the theoretical formation of these alloys with the results attained in practice. 1200 w. Comptes Rendus—Oct. 28, 1901. No. 44546 D.

Bronze.

Further Researches upon the Relation of the Strength of Bronze to its Temperature (Weitere Versuche über die Abhängigkeit der Zugfestigkeit und Bruchdehnung der Bronze von der Temperatur). C. Bach. A fully tabulated account of Prof. Bach's important and latest results. Zeitschr d Ver Deutscher Ing—Oct. 19, 1901. No. 44511 D.

Manila Rope.

Working Loads for Manila Rope. C. W. Hunt. Gives and discusses three tables showing the results of tests on manila ropes. 1800 w. Trans Am Soc of Mech Engrs, No. 917—Dec., 1901. No. 44447.

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Testing Machine.

A Belt and Pulley Testing Machine. C. M. Allen. Illustrated description of the apparatus used for making comparative pulley tests and belt tests. 1200 w. Jour Worcester Poly Inst—Nov., 1901. No. 44120 C.

MEASUREMENT.

Engineering Bureau.

A Project for an International Bureau of Engineering Data. Leicester Allen. A discussion of the necessity for fixed electrical and mechanical standards, urging the importance of an international bureau of standardization. 2500 w. Engineering Magazine—Dec., 1901. No. 44577 B.

Instruments.

A Few Meteorological Instruments. George M. Hopkins. Illustrated descriptions of a weather vane, a wind pressure gauge and a rain gauge. 1200 w. Sci Am—Nov. 16, 1901. No. 44367.

Spiral Springs.

Experiments on Spiral Springs. Charles H. Benjamin and Roy A. French. Describes a series of experiments on open springs in compression, made after the permanent set had been removed by forcing them closed solid in a testing machine. Load and deflection were measured, and conclusions stated. 1100 w. Trans Am Soc of Mech Engrs, No. 918—Dec., 1901. No. 44449.

POWER AND TRANSMISSION.

Bearings.

Tests of Roller Bearings. W. H. Booth. Reports some tests made on a new bearing in good order, and discusses the economy. 2900 w. Tram & Ry Wld—Oct. 17, 1901. No. 44186 B.

Cableway.

Shipping Coal by the Aërial Wire-Rope System at Port Morien, Cape Breton. Joseph G. S. Hudson. Abstract of a paper read before the Canadian Min. Inst. An illustrated description of the arrangements. 1000 w. Col Guard—Nov. 1, 1901. No. 44303 A.

Chain Gear.

A Silent Chain Gear. J. O. Nixon. States the objections to chain gearing, and gives an illustrated description of the chain gear developed by Hans Renold, of Manchester, Eng., stating its advantages. 2500 w. Trans Am Soc of Mech Engrs, No. 919—Dec., 1901. No. 44450.

Gear Teeth.

Considerations Affecting the Height of Gear Teeth. Robert A. Bruce. Gives records on squared paper of the results of a large number of calculations from formulas, and shows the importance of the increase of strength which attends any shortening of the normal addendum. 2300 w. Am Mach—Nov. 14, 1901. Serial. 1st part. No. 44353.

Journal Friction.

The Coefficient of Journal Friction (Zapfenreibung, Zapfenkraft und Koëffizient der Zapfenreibung). Dr. Camerer. A mathematical investigation of the action of the forces in a journal bearing, and their influence upon the friction. 1000 w. Zeitschr d Ver Deutscher Ing—Oct. 19, 1901. No. 44513 D.

Lubrication.

Lubrication of Machinery. Notes some of the points most essential in the lubrication of the bearings of modern machinery. Ill. 1600 w. Mod Mach—Nov., 1901. No. 44142.

Power Gas.

Power Gas (Kraftgas). P. Meyer. A general review of the products of various gas producers, and their direct application to motive power. Serial. Part I. 3500 w. Glasers Annalen—Oct. 15, 1901. No. 44531 D.

The Mond Gas Process (Mond Gas). R. Schöttler. A description of the Mond gas process, with plans of plant and a discussion of its advantages. 2500 w. Zeitschr d Ver Deutscher Ing—Nov. 9, 1901. No. 44521 D.

The use of Blast-Furnace Gases in Gas Engines (Verwendung der Hochofengase in Gasmaschinen). F. W. Lürmann. With tabulated analyses of the gases from furnaces in various districts, showing a mean calorific power of 877 calories per cubic metre. 1000 w. Stahl u Eisen—Nov. 1, 1901. No. 44538 D.

Power Plant.

Combined Steam and Hydraulic Power Plant at Richmond, Va. An illustrated description of the plant of the Virginia Electrical Railway and Development Co. 1500 w. Power—Nov., 1901. No. 44092.

Pulleys.

Tools for Machining Pulleys. Joseph Vincent Woodworth. Detail sketches of tools and fixtures for use in the turret lathe. Ill. 1200 w. Mach. N. Y—Nov., 1901. No. 44189.

Shaft Governors.

Modern Forms of Shaft Governor. H. F. Schmidt. Illustrates and describes various forms in use. 2500 w. Am Elect'n—Nov., 1901. No. 44239.

Speed Regulation.

The Determination of the Irregularities of Prime Movers (Ueber die Bestimmung des Ungleichformigkeitsgrades von Kraftmaschinen). Dr. R. Franke. Discussing especially the variations of speed during a single revolution and describing an apparatus for the investigation of speed va-

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riations. 5000 w. Elektrotech Zeitschr—Oct. 24, 1901. No. 44561 B.

Spiral Gears.

Spiral Gears. F. A. Halsey. An illustrated series of articles discussing the spiral-gearing problem. The present number is a comparison of spiral gears with spur gears, and the speed ratio. 2000 w. Am Mach—Nov. 14, 1901. Serial. 1st part. No. 44348.

Spiral Gearing Helps. E. M. Willson. Deals only with gears having an angle of spiral of 45 degrees, giving table and illustrations. 1200 w. Mach., N. Y—Nov., 1901. No. 44191.

Turntable.

Adjustable Turntable for Haulage Inclines. From Glückauf. Brief illustrated description of an apparatus designed to overcome the difficulties attending the switching of tubs in and out of haulage inclines. 800 w. Quarry—Nov. 1, 1901. No. 44292 A.

Water Power.

Water Power Development at Hanuawa Falls. Wallace C. Johnson. Gives figures in regard to the flow available; plans and views showing the construction of the dam, canal, waste gates, penstocks, gates, forebay and building, and a description of the wheels, generators, switchboard, transmission lines and the pulp plant, with its grinders, conveyors and water system. 4400 w. Trans Am Soc of Mech Engrs, No. 925—Dec., 1901. No. 44452 C.

Wire Rope.

The Operation of a Wire Rope in Multiple Laps. William Hewitt. An illustrated discussion of the difficulties met and ways of obviating them. 2500 w. Stevens Ind—Oct., 1901. No. 44078 D.

Worm Gearing.

Manufacturing Worms and Worm Gears. W. E. Willis. Illustrates and describes devices used in making small worm gears quickly and correctly. 1400 w. Am Mach—Oct. 31, 1901. No. 44086.

SPECIAL MOTORS.

Binary Engine.

Waste-Heat Auxiliary Engine. A series of pictures showing the latest developments in this engine, with information and report of results. 2000 w. Sci Am—Nov. 2, 1901. No. 44096.

Diesel Motor.

The Diesel Motor. Report of the Committee on Science and the Arts on the invention of Rudolf Diesel, of Munich, Bavaria. Awarding the Elliott-Cresson gold medal. Ill. 3400 w. Jour Fr Inst—Nov., 1901. No. 44226 D.

Gas Engines.

The Nash Gas Engines. Illustrates and describes the large engines installed in the Power Court at the Pan-American Exposition, and their operation. 1400 w. Ir Age—Oct. 31, 1901. No. 44083.

Internal Combustion.

Observations on Internal Combustion Motors (Beobachtungen an Explosionsmotoren). A. Weber-Sahli. With curves showing the gas consumption of various motors. 1200 w. Zeitschr d Ver Deutscher Ing—Nov. 2, 1901. No. 44520 D.

Valve Gears.

A New Valve Gear for Gas, Steam and Air Engines. Ernest W. Naylor. An illustrated description of a system of puppet valves, opened by the pull of electromagnets and closed by springs, stating the advantages. 1400 w. Trans Am Soc of Mech Engrs, No. 920—Dec., 1901. No. 44451.

STEAM ENGINEERING

Automatic Stokers.

Contract Tests of Automatic Stokers at the General Electric Works, Schenectady, N. Y. A report of elaborate tests made on twelve under-feed automatic stokers and also of a plant of Roney stokers. 4000 w. Eng News—Nov. 7, 1901. No. 44276.

Blowing Engines.

Blowing Engine Construction (Ueber Gebläsemaschinen). H. Braunne. Describing the improved Stupf-Riedler machine, with especial reference to the valve construction. 1200 w. Oesten Zeitschr f Berg u Hüttenwesen—Oct. 26, 1901. No. 44555 B.

Boiler Explosions.

Water-Tube Boiler Explosions in an English Electric Light Station. An account of two explosions at the Sardinia St. Station of Metropolitan Electric Supply Co. of London, with extracts from the Board of Trade report. Ill. 1800 w. Eng News—Nov. 21, 1901. No. 44474.

Boilers.

Instruction for Boiler Attendants. D. B. Dixon. Instructions applying more particularly to horizontal return tubular boilers, but in a general way applicable to all types of steam boilers. 2000 w. Am Mfr—Nov. 7, 1901. No. 44224.

Boiler Test.

See Mechanical Engineering. Automobiles.

Boiler Water.

To Determine the Weight of Water in a Boiler. Lawford H. Fry. Gives an approximate method. 1000 w. Am Engr & R R Jour—Nov., 1901. No. 44103 C.

Clearance.

An Experiment on the Effect of Clearance on the Economy of a Small Steam Engine. Albert Kingsbury. Describes ex-

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perimental work undertaken to determine the effect of varying clearance upon the steam consumption of a small automatic engine. 1800 w. Trans Am Soc of Mech Engrs, No. 923—Dec., 1901. No. 44453.

Combustion.

Loss in Economy by the Inefficient Combustion of Fuel. A. Bement. On the importance of gas analysis, with illustrated descriptions of instruments used. 3500 w. Am Elect'n—Oct., 1901. No. 44317.

Comparative Practice.

English, American, and Continental Steam Engineering. Philip Dawson. Mr. Dawson's second paper treats specifically of British lighting and traction plants and their equipment, with illustrations of many important stations. 4500 w. Engineering Magazine—Dec., 1901. No. 44572 B.

Cooling Tower.

Commercial Forms of Cooling Tower. C. W. Obert. Illustrated descriptions of various types. 3000 w. Am Elect'n—Oct., 1901. No. 44315.

Water Cooling Towers. B. Franklin Hart, Jr. Explains the use of cooling towers and the principle upon which they operate. 2000 w. Am Elect'n—Oct., 1901. No. 44314.

Dynamo Driving.

Engines for Driving Large Dynamos. Charles Day. Read before the Manchester Assn. of Engrs. Discusses the use of high-speed engines in England, describing a Ferranti engine and considering its advantages and disadvantages. Ill. 4000 w. Elect'n, Lond—Oct. 25, 1901. No. 44127A.

Engine Starting.

Starting a Cross Compound Condensing Engine. Detailed directions of the method to be followed. 4000 w. Power—Nov., 1901. No. 44093.

Exhaust Steam.

A Regenerative Accumulator for Exhaust Steam. Illustrated description of an apparatus receiving exhaust steam from engines having intermittent duty and furnishing low-pressure steam to engines requiring a steady supply. 500 w. Eng Rec —Nov. 9, 1901. No. 44211.

Feed Water.

The Purification of Feed Water. C. E. Stromeyer. A report dealing with results obtained in practical working with various types of purifiers, and remarks on the cleaning of boilers worked without purifiers. 4500 w. Ill. Engng—Oct. 25, 1901. No. 44143 A.

Heating Boilers.

European Heating Boilers. Charles F. Hauss. An article in three parts, describing and illustrating the European heating boilers. 1800 w. Met Work—Nov. 23, 1901. Serial. 1st part. No. 44483.

Power Plant.

The New Boiler Plant of the United Railways & Electric Company, Baltimore. Illustrated description of a very large steam generating station, the notes describing particularly the special details of the boiler plant, coal and ash handling apparatus, and structural steel work. 3200 w. Eng Rec—Nov. 2, 1901. No. 44145.

Power Stations.

New Power Stations of the St. Louis Transit Co. Illustrated detailed descriptions of the stations and their equipment. 5000 w. St Ry Rev—Nov. 15, 1901. No. 44461 C.

Separator.

The "Potter" Mesh Separator and Superheater. Frederick A. Scheffler. Describes the construction of this separator, which is made of a series of copper wire screens in a casing and placed inside the boiler on the outlet. Ill. 900 w. Trans Am Soc of Mech Engrs, No. 921—Dec., 1901. No. 44445.

Specifications.

Specification for Steam, Exhaust, Water and Condenser Piping for an Electric Power Station. A specification intended to cover the complete installation of steam piping, exhaust piping, injection and discharge piping, drain drip, blow-off and boiler feed piping, water piping, &c. 3600 w. Stevens Ind—Oct., 1901. No. 44080 D.

Speed Regulation.

Angular Variation in Steam Engines. P. O. Keilholtz. Report of investigations. Mathematical. 5800 w. Trans Am Inst of Elec Engrs—Oct., 1901. No. 44425 D.

Angular Velocity in Steam Engines in Relation to Paralleling of Alternators. Walter I. Slichter. Discusses variation due to irregularities in the applied force and transmission of that force. 3000 w. Trans Am Inst of Elec Engrs—Oct., 1901. No. 44426 D.

Speed Regulation of Prime Movers and Parallel Operation of Alternators. C. P. Steinmetz. Read before the Am. Inst. of Elec. Engrs. A discussion of the effect of permanent variations of rotative speed due to a change of load, temporary variations and periodic changes. 1200 w. Eng Rec —Nov. 2, 1901. No. 44147.

Steam Distribution.

Steam Distribution for Locomotive Engines. H. T. Herr. Extracts from a paper presented at the N. W. Ry. Club. Deals principally with valve motion, its design and importance. 2900 w. Ry Age—Nov. 1, 1901. No. 44193.

Steam Heating.

Heating Apparatus in St. Louis Schools. Illustrates some of the details of heater coils, especially the construction of the

We supply copies of these articles. See page 649.

steam header. 600 w. Eng Rec—Nov. 16, 1901. No. 44412.

Heating in a Large Group of Car Shops, Baltimore. Illustrated description of a plant for heating, by the fan system, buildings covering 8.7 acres. The plant embraces 4 fan-heater units, a special application of the Holly system of gravity return, and a water-tube boiler plant of 750 H. P. 1800 w. Eng Rec—Nov. 9, 1901. No. 44213.

Ventilating and Heating the Chicago National Bank. A combination plenum and exhaust system is used for distributing heated air in the basement and the first story, and direct radiation in the rest of the building. Plans. 3300 w. Eng Rec—Nov. 23, 1901. No. 44498.

Ventilating and Heating the Glasgow Art Galleries. Describes a group of buildings equipped with a ventilating and heating system comprising a plenum system of air distribution and a water-tube boiler plant for steam production. 1300 w. Eng Rec—Nov. 16, 1901. No. 44411.

Steam Pipes.

Transverse Stresses in Steam Pipes. A. S. Mann. The problem of calculating these stresses is discussed, and the factor of expansion that the writer has found from repeated measurements to be safe is given with explanation. 2000 w. Am Elect'n—Nov., 1901. No. 44237.

Steam Turbine.

The Steam Turbine. Illustrations with detailed description of the De Laval form of turbine, with editorial and historical review. 4800 w. Compressed Air—Nov., 1901. No. 44419.

Valve Gear.

See Mechanical Engineering, Special Motors.

Wastes.

Neglected Heat Wastes. R. A. Douglass. Discusses losses from radiation, leakages, excessive use of the blow-off for flushing, &c. 2000 w. Am Elect'n—Nov., 1901. No. 44234.

MISCELLANY.

Aeronautics.

Count de la Vaulx Balloon "Mediterranéen." A brief account, with illustrations, of the recent attempt to cross the Mediterranean in a balloon. 1100 w. Sci Am Sup—Nov. 23, 1901. No. 44469.

Santos-Dumont Wins the Deutsch Prize. Reviews the work of this aëronaut and his success. Ill. 1000 w. Sci Am—Nov. 16, 1901. No. 44369.

The Roze "Aviator." An illustrated description of the apparatus M. Roze is constructing. 1000 w. Sci Am Sup—Nov. 9, 1901. No. 44232.

The Santos-Dumont Motor Balloon. An illustrated account of the trial made on Oct. 11, when the breaking of the rudder made it necessary to abandon the trip around the Eiffel tower. 1400 w. Autocar—Oct. 19, 1901. No. 44085 A.

Air Resistance.

Modern Theories of Air Resistance. (Die Luftwiderstandsgesetze in Neuster Zeit). F. R. v. Loessh. An examination of the laws of air resistance in connection (Die Luftwiderstandsgesteze in Neuster d Oesterr Ing u Arch Ver—Oct. 18, 1901. No. 44526 B.

Ballistics.

The Trajectory of a Rifle Ball (Trajectoire d'une Balle de Fusil). A mathematical study, based upon data from modern weapons. 2500 w. Revue Technique—Oct. 25, 1901. No. 44510 D.

Clock.

A New Remontoir Clock. Illustrated description of a clock mechanism having new features of interest to the designers of fine machinery. 2800 w. Mach, N. Y—Nov., 1901. No. 44190.

Exposition.

Some Novel Features of the Pan-American Exposition. Herbert Croly. An illustrated article discussing the plan and purpose of the exposition and its features of interest. 4400 w. Archt Rec—Oct., 1901. No. 44116 C.

Field Glasses.

The How and the Why of the Porro Prism Field-Glass. Worcester Reed Warner. An illustrated article giving an analysis of the principles involved. 2600 w. Trans Am Soc of Mech Engrs, No. 927—Dec., 1901. No. 44624.

Heating.

European Warm Air Furnaces. Charles F. Hauss. Brief illustrated descriptions of designs, with general remarks. 2500 w. Met Work—Nov. 2, 1901. No. 44123.

Warming a Chapter House. Illustrated description of interesting features in the system used for the Beta Theta Pi Chapter House in Syracuse. 1700 w. Met Wk—Nov. 9, 1901. No. 44182.

Ice Making.

The Ice Producing Plant in Vienna (Die Eisfabrik der Approvisionierungs-Gewerbe in Wien). J. Hermanck. Illustrating and describing the new large plant in Vienna, using carbonic acid gas. 2000 w. 1 plate. Zeitschr d Oesterr Ing u Arch Ver—Nov. 8, 1901. No. 44529 B.

Mechanical Antiquities.

Mechanical Antiquities of America. Edward P. Buffet. The present article gives the history of Henry F. Frasse, an old New York machinist, and his work. Ill. 2200 w. Am Mach—Nov. 21, 1901. Serial. 1st part. No. 44458.

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Pens.

The Manufacture of Steel Pens. Describes the making of steel and of gold pens. Ill. 2200 w. Ir & Coal Trds Rev—Nov. 1, 1901. No. 44302 A.

Sugar Machinery.

A Sugar-Cane Triple-Crushing Plant. A. E. Jordan. Describes a sugar-cane-crushing plant erected and in operation at Baliàna, Upper Egypt; the installation is guaranteed to crush 750 tons of cane per day of 22 hours. Ill. 1600 w. Engng—Nov. 8, 1901. 44338 A.

Topical Discussion.

Topical Discussions and Notes of Experience. Prof. F. R. Hutton discusses what it costs to run trains at high speed; Stephen W. Baldwin considers some peculiarities of springs; and F. F. Nickel considers the "Linvolpon" system of units. 2700 w. Trans Am Soc of Mech Engrs, No. 914—Dec., 1901. No. 44443.

MINING AND METALLURGY

COAL AND COKE.

Bituminous Coal.

Burning Bituminous Coal. W. H. Booth. Discusses the difficulties encountered in effecting complete combustion, their causes, and means for remedying them. 3000 w. Mines & Min—Nov., 1901. No. 44220 C.

Briquettes.

Manufacture of Briquettes from Wood Waste. Gustaf v. Heidenstam. Extract from a report of the results obtained by investigations and experiments carried out by the writer, as to the manufacture and carbonization of briquettes from the waste of lumber and saw mills. Ill. 3000 w. Engr, Lond—Nov. 1, 1901. No. 44311 A.

Coal Exports.

See Industrial Economics.

Coal Loading.

Coal-Loading Appliances at Bethune. A. da Cunha, in *La Nature*. Illustrates and describes an installation for loading canal boats from the Marles Colliery. The coal is discharged by gravitation. 8000 w. Col Guard—Nov. 1, 1901. No. 44304 A.

Scotland.

The Hamilton Coalfield. Describes this coal district, one of the most important in Scotland, its deposits, development, mode of working, etc. 3500 w. Ir & Coal Trds Rev—Oct. 25, 1901. No. 44131 A.

COPPER.

Tasmania.

Mining in Tasmania. George A. Waller. A report on the Scamander River and St. Helens. The metals consist principally of copper, tungsten and tin. 9200 w. Aust Min Stand—Sept. 19 and 26, Oct. 3 and 10, 1901. Serial. 4 parts. No. 44286 each B.

Virgilina District.

The Virgilina Copper District. L. N. White. An account of a territory on the Atlantic border giving promise of exceedingly good results. Ill. 4200 w. Min & Met—Nov. 15, 1901. No. 44456.

Wertago.

The Wertago Copper Field. J. B. Jaquet. Reports an examination of this field in New South Wales, considering it capable of yielding a quantity of ore, but impeded by the location, and the lack of water. 1500 w. Aust Min Stand—Sept. 19, 1901. No. 44287 B.

GOLD AND SILVER.

Assay Office.

The United States Government Assay Office at Seattle. A. W. Dee. Concerning the equipment of this office and its method of procedure. Ill. 1700 w. B C Min Rec—Nov., 1901. No. 44472 B.

British Columbia.

Texada Island. William M. Brewer. An illustrated article concerning the northern part of the island. Gold bearing quartz, copper ores, iron and other minerals of value are found. Reports the development of the mines and geological conditions. Ill. 3500 w. Eng & Min Jour—Nov. 23, 1901. No. 44488.

The Snowshoe Mine, Boundary District, B. C. E. Jacobs. An illustrated description of this mine and its development. The ores vary in character. The assay of a representative sample showed gold, silver, copper, iron, lime and silica. 2000 w. Eng & Min Jour—Nov. 23, 1901. No. 44485.

Concentration.

Pneumatic Concentration. E. B. Wilson. Describes the process, and the method of construction and operation of the Hooper concentrator. 1500 w. Mines & Min—Nov., 1901. No. 44217 C.

Dredging.

Gold Dredging in North Georgia. Henry V. Maxwell. Illustrations with brief descriptions of methods. 500 w. Eng & Min Jour—Nov. 2, 1901. No. 44170.

Late Gold-Dredging Practice. Ralph L. Montagu. Describes an attempt to use this method in Montana in 1894, and the difficulties met; also discusses the economic advantages of dredging methods. 2100 w. Min & Sci Pr—Nov. 2, 1901. Serial. 1st part. No. 44181.

The Gold-Dredging Fields of Eastern

We supply copies of these articles. See page 649.

Russia. C. W. Purington and J. B. Landfield, Jr. A fully illustrated study of the auriferous gravels of Eastern Russia, showing the favorable conditions for electric mining. 4000 w. Engineering Magazine—Dec., 1901. No. 44576 B.

Klondike.

An English Observer on the Klondike Gold-Fields. From the London *Economist*. Extracts from a letter written by an observer of experience. Considers the alluvial gravels very rich and explains the excessive cost of treating them. 1300 w. Eng & Min Jour—Nov. 23, 1901. No. 44489.

Korea.

Quartz Mining in Korea. Describes mines and their operation. Ill. 1300 w. Min & Sci Pr—Nov. 2, 1901. No. 44180.

Nevada.

Tonopah. An illustrated descriptive article telling the story of this rich mining district in Nevada. 3000 w. Min & Sci Pr—Nov. 9, 1901. No. 44363.

Nome.

The Season of 1901 at Nome. Herbert Murray. A review of the year and the conditions under which the work has been carried on. 1800 w. Eng & Min Jour—Nov. 23, 1901. No. 44486.

Queensland Ores.

Concentration and Smelting. W. A. Macleod. Deals with the treatment of auriferous ores in Queensland. 2300 w. Aust Min Stand—Sept. 26, 1901. No. 44288 B.

South Africa.

The Kaffir Miners of the Johannesburg Gold Mines. T. Lane Carter. Describes how they work and how they are managed. Ill. 1600 w. Mines & Min—Nov., 1901. No. 44219 C.

Transvaal.

Mining Outlook in the Transvaal. T. S. Parrott. Discusses the great producing power of this field, the difficulties encountered, the past history, etc. 3300 w. Aust Min Stand—Oct. 10, 1901. Serial. 1st part. No. 44290 B.

Wet Crushing.

A Direct Wet-Crushing Cyanide Mill of the Black Hills. Everett B. Sawyer. Describes the general practice of this mill. Ill. 2800 w. Min & Sci Pr—Nov. 16, 1901. No. 44465.

IRON AND STEEL.

Blast-Furnaces.

Experience with an American Blast Furnace Erected at Mariupol. A. Brezgunow. Condensed translation from *Stahl und Eisen*. Illustrated description with criticisms. 1900 w. Ir & Coal Trds Rev—Oct. 25, 1901. No. 44130 A.

The Eliza Furnace Plant. Illustrated detailed description of this fine plant in Pittsburgh. 3800 w. Ir Age—Oct. 31, 1901. No. 44082.

Chromite.

Chromite or Chromic Iron Ore. Joseph Hyde Pratt. Information concerning chromium, its uses, its source, alloys, etc., where deposits are found, cost, etc. 2800 w. Am Mfr—Nov. 21, 1901. No. 44481.

Deposits.

The Iron Ore Deposits of Gunnison County. Dr. J. Ohly. Describes the deposits, and gives anaylses, discussing the outlook for the development of this field. 1700 w. Min Rept—Nov. 21, 1901. No. 44634.

Iron Industry.

Twenty-five Years of Engineering Progress in the Iron Industry. John Birkinbine. A review of advances, with sketches and photographs of prominent men engaged in the industry. 10,000 w. Ir Trd Rev—Nov. 14, 1901. No. 44374.

Japan.

The Kamaishi Iron Works (Die Kamaishi-Eisenwerke). E. Bahlsen. A general description of an important Japanese iron works, which has been in operation since 1823, using native ores. 2500 w. Stahl u Eisen—Nov. 15, 1901. No. 44542 D.

Liquid Fuel.

The Use of Naphtha Residues in the Iron Works of Russia (Emploi des Residus de Naphte dans les Usines Sidérurgiques de Russie). A. Abraham. Showing the method of using mazout and other petroleum residues for firing boilers and open-hearth furnaces. 2500 w. Génie Civil—Nov. 2, 1901. No. 44505 D.

New Process.

A New Direct Iron and Steel Process. Abstracts of papers describing a new direct process for the production of malleable iron and steel from the ore, invented by J. Rudolph and J. Landin. 1500 w. Col Guard—Nov. 15, 1901. No. 44619 A.

Open Hearth.

A Summary of Development in Open-Hearth Steel. An illustrated review of the various open-hearth furnaces and the changes made in them. 5500 w. Ir Trd Rev—Nov. 14, 1901. No. 44377.

Siemens Open Hearth Steel Furnace. Basil Turner. Describes the Siemens process, the furnace and its operation, dealing mainly with the Lithgow furnace. Ill. 7500 w. Aust Min Stand—Sept. 26, Oct. 3, 10, 1901. Serial. 3 parts. No. 44289 each B.

Rolled Material.

The Development of Rolled Structural Shapes. F. H. Kindl. Reviews the history of rolled material and its applications, discussing the principles upon which the pres-

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ent standards were founded. 4000 w. Ir Trd Rev—Nov. 14, 1901. No. 44376.

Rolling Mills.

Improved Electric Driving for Rolling Mills (Neue Elektrische Antriebe bei Trio-, Blech-, und Universalwalzwerken). A. Schwarze. With especial reference to the operation of the rising and falling tables, and auxiliary machinery for three-high mills, etc. 2500 w. Stahl u Eisen—Oct. 15, 1901. No. 44536 D.

Landmarks in the Rolling Mill History of the United States. William Garrett. Reviews the progress, calling attention to the most striking phases in the development, and giving short sketches of men prominent in the work, with photographs. 9000 w. Ir Trd Rev—Nov. 14, 1901. No. 44373.

The Rolling Mill of the Present (Die Walzwerks-Einrichtungen der Gegenwart). A. Sattmann. A general review of modern rolling mill practice, with especial reference to the specialization of the various departments of the industry. Serial. Part I. 2500 w. Stahl u Eisen—Nov. 15, 1901. No. 44541 D.

Russia.

Anthracite Blast Furnaces in Southern Russia (Die Anthracithochöfen in Südrussland). O. Simmersbach. Giving comparisons of the constitution of American and Russian anthracite, and profiles of furnaces. 1800 w. Stahl u Eisen—Oct. 15, 1901. No. 44537 D.

Santiago Ores.

The Iron Ores of Santiago, Cuba. Arthur C. Spencer. Observations concerning the occurrence and origin of these ores. Ill. 2200 w. Eng & Min Jour—Nov. 16, 1901. No. 44385.

Steel Manufacture.

Twenty-five Years' Progress in the Use of Alloys and Metals in Steel Manufacture. Albert Ladd Colby. A general review of the difficulties which have been overcome in the manufacture and treatment of "special steels," with reference to the important uses. Analyses of the steels and ferro-alloys used are given. Also brief biographical sketches of men prominent in this field. 6300 w. Ir Trd Rev—Nov. 14, 1901. No. 44375.

MINING.

Accidents.

Death by Electricity. Discusses the accident at Exhall Colliery, and discusses electric power services in mines, and the precautions necessary. 3500 w. Col Guard—Nov, 15, 1901. No. 44618 A.

Air Compressor.

The New Collmann Air Compressor at the Harpen Mines at Dortmund (Die Neuen Collman Luft Kompressoren der Zechen "Caroline" und "Vollmond" der Harpener Bergbau Aktien Gesellschaft zu Dortmund). F. Schulte. With a full data of dimensions and performance, and reproductions of indicator diagrams. 1500 w. 1 plate. Glückauf—Nov. 9, 1901. No. 44552 B.

Alaska.

The Ketchikan Mining District, Alaska. William S. Brewer. Gives the boundaries of this district, which includes many islands, producing gold, silver, and copper ores. Describes the country and the difficulties that must be overcome by prospectors. 3000 w. Eng & Min Jour—Nov. 16, 1901. No. 44384.

Laboratory Work.

Notes on Some Work Recently Done in the Mining Laboratories of McGill University. J. B. Porter. Read before the Canadian Min. Inst. An exposition of the methods of teaching . 2500 w. Can Min Rev—Oct. 31, 1901. No. 44167 B.

Malay Peninsula.

Mineral Features of Pahang, Malay Peninsula. F. J. Stephens. Read before the Inst. of Min. & Met., London. Describes the country, its geological features, its minerals, etc. Gold is found in paying quantities, and copper is also found extensively. 2000 w. Eng & Min Jour—Nov. 2, 1901. No. 44171.

Mexico.

Geographic and Geologic Features of Mexico. Robert T. Hill. Notes on their relations to the mineral products. Map. 4900 w. Eng & Min Jour—Nov. 2, 1901. No. 44169.

Old Time Mining in Mexico. O. H. Howarth. Describes the methods and tools used by the ancient miners and their processes of reducing the ore. Ill. 4000 w. Mines & Min—Nov., 1901. No. 44218 C.

The Mining Industries of Mexico. H. L. Geissel. Illustrated account of a rich mining field, the progress in the mining and metallurgical industries, etc. Gold, silver, copper, quicksilver, lead, iron, asphaltum and other valuable products are found. 3000 w. Min & Met—Nov. 1, 1901. No. 44174.

Mine Pumping.

Hydraulic Mine Pumps (Machines d' Epuisement Hydrauliques). M. Seurat. A description of underground hydraulic transmission for the operation of mine pumps, with especial reference to German practice. 2500 w. 1 plate. Génie Civil—Nov. 2, 1901. No. 44503 D.

The Pumping Plant of the Compania Minera y Metalúrgica del Horcajo (Wesserhaltung der Compania Minera y Metalurgica del Horcajo). F. Heerwagen. An illustrated account of the centrifugal pumps at the Horcajo Mine in the province of Ciudad Real, Spain. 4000 w. Zeitschr d Ver Deutscher Ing—Nov. 2, 1901. No 44517 D.

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Mining Machine.

The Historical Development of the Pick Type of Mining Machine. L. J. Daft. Historical review noting the changes and improvements that have led to the present machine. General discussion. Ill. 9000 w. Pro Engrs' Soc of W. Penn—Nov., 1901. No. 44421 D.

Mining Plant.

See Electrical Engineering, Power Applications.

Mining Structures.

A Model Tramway and Sampler. James H. Steel. Illustrates and describes the new 250-ton automatic sampler and aërial wire-rope tramway of the Silver King Mining Co., in Utah. Also describes the method of working the plant. 2000 w. Eng & Min Jour. Nov. 9, 1901. No. 44267.

Missouri.

Mining Practice in Southeast Missouri. R. B. Brinsmade. Illustrated description of the country, the mines, and the method of prospecting and working. 5000 w. Mines & Min—Nov., 1901. Serial. 1st part. No. 44214 C.

Rock Drill.

See Elctrical Engineering, Power Applications.

Shaft Sinking.

A piece of Difficult Shaft Sinking in Developing the Salt Mines of Grand Cote Island, Louisiana. J. N. Hazlehurst. A report of this property, its geography, history and development, with an illustrated description of the execution of this work. 3900 w. Eng News—Nov. 7, 1901. No. 44275.

The Removal of Water in Sinking the Schöller Shaft at Libuschin near Kladno. V. Kadainka. Describing the use of compressed air to clear a mine shaft of water during the operation of deepening. 1800 w. 1 plate. Oesterr Zeitschr f Berg u Hüttenwesen—Oct. 26, 1901. No. 44554 B.

Shot-Holes.

Stemming Shot Holes. From *Annales des Mines.* Report by the French committee on explosives, on experiments made. Ill. 1700 w. Col Guard—Oct. 25, 1901. No. 44132 A.

Timbering.

The Employment of Iron Bars at the No. 6 Pit, Lens Colliery, France. E. Reumaux. Illustrates and describes the form of bars and method of using them to support the roof while working. 1000 w. Mines & Min—Nov., 1901. No. 44222 C.

Tunnels.

Tunnel Schemes. Arthur Lakes. Compares the Standard, or Cripple Creek, with the Rothsöhnberger Stollen tunnel, of Freiburg, Germany. 2200 w. Mines & Min—Nov., 1901. No. 44221 C.

Turn Table.

Improved Turntable for Inclined Planes (Verstellbare Drehscheibe für Geneigte Bahnen). A description of the "Best" turntable for transferring cars from inclined to horizontal tracks. 1800 w. Oesterr Zeitschr f Berg u Hüttenwesen—Oct. 19, 1901. No. 44553 B.

Vancouver.

The Mineral Resources of Vancouver Island. W. M. Brewer. Abstract of an article published in the "Victoria *Times* Royal souvenir number." An illustrated review of its mineral resources and their development. 6000 w. B C Min Rec—Nov., 1901. No. 44471 B.

West Virginia.

Geology of West Virginia. Dr. I. C. White. History and description of the different formations and the minerals found in them. 4000 w. Mines & Min—Nov., 1901. No. 44216 C.

MISCELLANY.

Aluminum.

Aluminum and Bauxite. Joseph Pratt Hyde. On the sources and uses of aluminum. 2000 w. Am Mfr—Oct. 31, 1901. No. 44163.

Diamonds.

The Diamond Deposits of Salobro, Brazil. Prof. F. de Paulo Oliveira. Describes the region and what is known of the deposits, giving an account of the discovery. 2800 w. Eng & Min Jour—Nov. 16, 1901. No. 44386.

Gypsum.

The Mining and Milling of Gypsum in Kansas. W. R. Crane. Describes the gypsum bearing localities and methods of working and treatment. Ill. 1800 w. Eng & Min Jour—Nov. 9, 1901. No. 44268.

Lithographic Stone.

The Production and Consumption of Lithographic Stone. S. J. Kubel. Abstract of a paper in *Mineral Resources of the United States,* 1900. Concerning the sources of supply, and investigations of stones in the United States. 1600 w. Eng & Min Jour—Nov. 23, 1901. No. 44490.

Petroleum.

Casing and Tubing for Oil Wells. Illustrated discussion of types used, and the abuse to which the casing is subject. 1700 w. Am Mfr—Oct. 31, 1901. No. 44162.

Oil Springs of Rio Blanco County, Colorado. Arthur Lakes. Illustrated description of the Whiskey Creek oil region, with analyses of the oil. 3500 w. Mines & Min—Nov., 1901. No. 44215 C.

The Present Outlook for the California Oil Industry. W. J. Young. Reviews the production, the work in progress in the oil-fields, and considers the outlook encourag-

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ing. 1600 w. Eng & Min Jour—Nov. 23, 1901. No. 44487.

Petroleum from the Beaumont, Texas, Field. Clifford Richardson and E. C. Wallace. Read before the Soc. of Chem. Ind., New York. The extent of the field, with an outline of the methods used in analyzing the product, and general information. 2500 w. Sci Am Sup—Nov. 9, 1901. No. 44231.

The Production of Petroleum in 1900. F. H. Oliphant. Reviews the features of the production in the United States. 2500 w. Am Mfr—Oct. 31, 1901. No. 44164.

Tin.

Tin Supplies. Editorial on the supply in the Malay States, based on information given in the last annual report and claiming that there is no cause for anxiety concerning the future supply. 1300 w. Engng—Nov. 15, 1900. No. 44617 A.

RAILWAYS AND TRAMWAYS.

CONDUCTING TRANSPORTATION.

Accidents.

Train Accidents in the United States in September. A record of the most prominent railroad accidents during the month, with editorial comments. 3500 w. R R Gaz—Nov. 15, 1901. No. 44398.

Baggage Handling.

Baggage Handling at the Quai d'Orsay, Paris. From the *Revue Générale des Chemins de Fer.* An illustrated description of the method used at this station of the Orleans Railway. 1200 w. R R Gaz—Nov. 15, 1901. No. 44397.

Chicago.

Chicago Committee on Local Transportation. A paper prepared by George C. Sikes containing suggested outlines of street railway franchise renewal ordinances for Chicago, with a description of some of the features of the case. 2300 w. St Ry Rev—Nov. 15, 1901. No. 44464 C.

Despatching.

Train Despatching. Extracts from a paper by C. N. Woodward, read before the New England R. R. Club. Discusses the work and the practice, the men and the service. 2000 w. R R Gaz—Nov. 8, 1901. No. 44281.

Ferry Transfers.

A Railroad Ferry Transfer. Illustrated description of the arrangements for ferrying trains across the Kennebec River, between Bath and Woolwich. 1100 w. Eng Rec—Nov. 23, 1901. No. 44492.

Freight.

Forwarding Companies and Consolidated Shipments. A ruling concerning the right of the railroads to refuse to transport at carload rates, shipments of less than carload lots which have been consolidated, with editorial discussion. 2000 w. Ry & Engng Rev—Nov. 2, 1901. No. 44179.

Goods Conveyance.

The Conveyance of Goods on Electric Trolley Lines. Alfred H. Gibbings. Outlines a system for Great Britain, pointing its advantages. 3600 w. Tram & Ry Wld—Oct. 17, 1901. No. 44187 B.

Handling Crowds.

The Railway Problem as Applied to the Louisiana Purchase Exposition to be Held in St. Louis, A. D. 1903. Charles E. Koons. Suggestions in connection with transportation of exhibits and people, and the general management of affairs. 2000 w. St. Louis Ry Club—Oct. 11, 1901. No. 44076.

The Railway Problem as Applied to the Louisiana Purchase Exposition to be Held in St. Louis, A. D. 1903. George Hannauer. Brief suggestions advising the organization of a separate World's Fair Freight Terminal. 900 w. St. Louis Ry Club—Oct. 11, 1901. No. 44077.

The Railway Problem as Applied to the Louisiana Purchase Exposition to be Held in St. Louis, A. D. 1903. H. J. Pfeifer. Discusses the railroad business in connection with the proposed fair, giving suggestions for the arrangements needed. 4000 w. St. Louis Ry Club—Oct. 11, 1901. No. 44075.

The Railway Problem as Applied to the Louisiana Purchase Exposition to be Held in St. Louis, A. D. 1903. Jno. J. Baulch. Suggestions for the efficient handling of the construction work, transport of materials and exhibits, and prompt transportation of passengers. 3300 w. St. Louis Ry Club—Oct. 11, 1901. No. 44074

The Railway Problem as Applied to the Louisiana Purchase Exposition to be Held in St. Louis, A. D. 1903. William R. Brannan. Outlines the conditions at St. Louis and a plan for satisfactorily caring for the crowds of people expected. 3000 w. St. Louis Ry Club—Oct. 11, 1901. No. 44073.

The Railway Problem as Applied to the Louisiana Purchase Exposition to be Held in St. Louis, A. D. 1903. Discussion of the prize papers on this subject, by A. T. Perkins and others. 3200 w. St. Louis Ry Club—Nov. 8, 1901. No. 44637.

Operation.

The Operation of the "Great Gorge Route." Godfrey Morgan. An illustrated article presenting the facts and problems of operation and maintenance. 2000 w. St Ry Rev—Nov. 15, 1901. No. 44462 C.

We supply copies of these articles. See page 649.

FINANCIAL.

Cost Reducing.

Cost Reducing Methods in Railroad and Car Shops. George W. Scott. Discusses the advantage of improved plant facilities, well selected machinery, improved methods, etc. 2000 w. Ry & Engng Rev—Nov. 2, 1901. No. 44178.

Tramways Act.

The Economic Effect of the Tramways Act of 1870. E. F. Vesey Knox. Read before the British Assn. at Glasgow. Gives reasons why the writer believes it to have been the most disastrous legislative experiment attempted in England. 6500 w. Tram & Ry Wld—Oct. 17, 1901. No. 44188 B.

MOTIVE POWER AND EQUIPMENT.

Boston Elevated.

The Boston Elevated Railway. J. A. Stewart. Particulars of interest especially in regard to the recently opened Atlantic Avenue circuit. Ill. 1300 w. Sci Am Sup—Nov. 2, 1901. No. 44097.

Brakes.

Brakes in Railroad and Street Car Service. General discussion of this subject. 23000 w. N Y R R Club—Oct. 17, 1901. No. 44420.

Car Lighting.

The Adlake System of Acetylene Gas Car Lighting. An illustrated description of the apparatus, with an explanation of how the needed conditions have been met. 2800 w. R R Gaz—Nov. 22, 1901. No. 44478.

Works for Rich Gas and Acetylene (Usine à Gaz Riche et à Acétylène). H. Guérin. A description of the plant for generating a rich coal gas, and its further enrichment with acetylene for the carriages of the Paris-Lyons-Mediterranean railway. 1200 w. Génie Civil—Oct. 26, 1901. No. 44502 D.

Cars.

Eighty Thousand Pounds Capacity Tank Cars. Illustrated description of cars for the Atchison, Topeka & Santa Fe Railway for carrying oil or water. 400 w. Am Engr & R R Jour—Nov., 1901. No. 44104 C.

The Vanderbilt Steel Hopper Coal Car, 100,000 Pounds Capacity. Illustrates and describes an interesting car of new design. 1000 w. Am Engr & R R Jour—Nov., 1901. No. 44100 C.

Ceylon.

The Electric Tramway in Colombo, Ceylon. H. S. Morrison. Illustrated description of a line that has been running satisfactorily about three years and is to be extended. 1600 w. St Ry Jour—Nov. 2, 1901. No. 44202 D.

Compound Locomotives.

Valve Gear for Compound Locomotives (Steurung für Verbund lokomotiven). M. Kuhn. Describing a form of valve gear permitting a variable cut-off in the high pressure, and fixed cut-off in the low pressure cylinder. 2500 w. 1 plate. Glasers Annalen—Nov. 1, 1901. No. 44533 D.

Couplers.

The M. C. B. Coupler. R. P. C. Sanderson. A short paper discussing some of its shortcomings and the remedy, with general discussion. 11000 w. W Ry Club—Oct., 1901. No. 44418 C.

Electric Railways.

Electric Traction on the Invalides-Versailles Line (La Traction Electrique sur la Ligne des Invalides à Versailles). F. Drouin. Describing especially the running of the feeders, also the substations and motor cars. 3000 w. 1 plate. Génie Civil—Oct. 26, 1901. No. 44500 D.

Electric Traction on the Main Railway Lines of Switzerland (Elektrischen Betrieb auf den Schweizerischen Hauptbahnen). L. Thormann. A study of the possibility of operating the main Swiss railways by electricity, using water power plants. Serial. Part I. 2000 w. Schweizerische Bauzeitung—Nov. 9, 1901. No. 44558 B.

The Electrification of the Metropolitan and Metropolitan District Railways. A report of the discussion at meeting held to decide what system of electric traction shall be employed. 3500 w. Engng—Nov. 1, 1901. No. 44307 A.

The Electric Motor in Competition with the Steam Locomotive. Editorial discussion of how far the electric motor has proved a success, and a review of several recent papers bearing on this subject. 2400 w. Eng News—Nov. 14, 1901. No. 44393.

Equipments.

Four-Motor Equipments. Gives reasons why many companies prefer to use four motors per car. Ill. 2400 w. Sci Am Sup—Nov. 2, 1901. No. 44098.

Europe.

European Railroad Jottings. Charles Rous-Marten. Describing some recent engines showing a radical reform in freight-train practice in England. Ill. 1600 w. Loc Engng—Nov., 1901. No. 44173 C.

Firing.

Best Method of Firing Locomotives. Gives the report of the committee of the Traveling Engineers' Assn. 1700 w. Ry & Engng Rev—Nov. 16, 1901. No. 44403.

Leeds.

City of Leeds Electric Tramways. Illustrated detailed description of the present tramway system. 3200 w. Tram & Ry Wld—Oct. 17, 1901. No. 44183 B.

We supply copies of these articles. See page 649.

Line Polarity.

Freaks Due to Reversal of Line Polarity. Two instances are given in illustration. 1500 w. Am Elect'n—Oct., 1901. No. 44320.

Locomotive Balancing.

The Balancing of Locomotives. Prof. W. E. Dalby. Explains and illustrates a convenient semi-graphical method of obtaining the magnitude and position of the balance weights, and the different ways of dealing with the reciprocating masses in coupled engines, considering the effect of the balance weights on the permanent way and on the tractive force of the engine. Ill. 6800 w. Inst of Mech Engrs—Nov., 1901. No. 44614 D.

Locomotive Tests.

Tests of Light and Heavy Locomotives. Tabulated results, showing heavy locomotives to be advantageous when they may be loaded to capacity. 1100 w. Am Engr & R R Jour—Nov., 1901. No. 44102 C.

Locomotives.

A Baldwin Freight Engine of 1847. C. H. Caruthers. Illustrated description. 1300 w. R R Gaz—Nov. 15, 1901. No. 44399.

American vs. British Locomotives in India. A letter from the chief engineer of the Bengal Central Railway, comparing the performance and cost. 500 w. U S Cons Repts, No. 1184—Nov. 8, 1901. No. 44160 D.

A Study of American Locomotives (Etude sur les Locomotives Americaines). J. Oudet. An exhaustive study of the details of American locomotive construction from a French standpoint. Serial. Part I. 15000 w. Revue de Mécanique—Oct. 31, 1901. No. 44534 E + F.

Brooks Locomotive for San Pedro, Los Angeles & Salt Lake Railway. Illustrated description of an oil-burning engine for passenger trains. 250 w. Loc Engng—Nov., 1901. No. 44172 C.

Compound Locomotive, Bulgarian State Railways. Illustration with brief description. 500 w. Engr, Lond—Oct. 25, 1901. No. 44136 A.

Compound Locomotive, Bulgarian State Railways. Sectional drawings and description. 2500 w. Engr, Lond—Nov. 15, 1901. No. 44620 A.

Express Locomotive, Eastern of France Railway. Illustrated description of an engine designed for service from Paris to Belfort, where fast and heavy trains have to be hauled up long gradients of 6 in 1000. 700 w. Engng—Oct. 25, 1901. No. 44138 A.

Foreign-Built Locomotives. Editorial discussion of the American built locomotives sent to England and India. Also considers German competition. 2000 w. Engng—Nov. 8, 1901. No. 44339 A.

Locomotives for India. Editorial on the orders India has given to Germany for locomotives, and the importance to England of foreign industrial competition. 3000 w. Engng—Oct. 25, 1901. No. 44140 A.

Oil-Burning Locomotives on the Gulf, Colorado & Santa Fe. Drawing and information concerning the locomotives equipped for this road. 1500 w. R R Gaz—Nov. 22, 1901. No. 44479.

Pennsylvania Moguls—Classes F-3 and F-3-b. Illustrations and brief description of the latter class, with points of difference between this engine and Class F-3. 500 w. R R Gaz—Nov. 1, 1901. No. 44207.

Performance of Class I and Class C Locomotives—New York Central Railroad. Indicator diagrams from both classes, with train data and profiles of the divisions in which the work was done. 500 w. R R Gaz—Nov. 1, 1901. No. 44206.

Prairie Type Passenger Locomotives, Atchison, Topeka & Santa Fe. General description, with illustrations of a design for handling fast and heavy work. Also editorial discussion. 2000 w. R R Gaz—Nov. 22, 1901. No. 44477.

Some Unusual Locomotives. A. B. Eddowes. Illustrated descriptions of types selected for their engineering interest. 9200 w. Pro Engrs' Club of Phila—Oct., 1901. No. 44432 D.

The Power of a Locomotive and Its Steaming Capacity. David L. Gallup. Reports investigations of tractive power made on Boston & Maine wide fire-box locomotives. 1300 w. Jour Worcester Poly Inst—Nov., 1901. No. 44121 C.

Weight and Capacity of Locomotives with Vanderbilt Boilers and Tenders. Editorial discussion of this design as compared with other locomotives. 1800 w. R R Gaz—Nov. 15, 1901. No. 44400.

Multiple-Unit.

The Multiple Unit System of Electric Traction (Traction Electrique à Unités Multiples). A general description of the Sprague system, as used on the Western Railway of France. 1500 w. Génie Civil—Oct. 26, 1901. No. 44501 D.

New York.

Electric Traction on the New York Elevated Railway (Der Neue Elektrishe Betrieb der New Yorker Stadtbahn). A. Hruschka. A general account of the plans for the conversion of the New York elevated railway, including the line, the power house and the electric plant. Serial. Part I. Elektrotech Zeitschr—Oct. 17, 1901. No. 44559 B.

Portsmouth, Eng.

Portsmouth Municipal Electric Tramways. Illustrated description of an overhead system and equipment. 3200 w. Tram & Ry Wld—Oct. 17, 1901. No. 44184 B.

We supply copies of these articles. See page 649.

Railway Motors.

The Service Capacity of Railway Motors. N. W. Storer. A reply to an article by A. H. Armstrong in the April number of this journal, criticising a former article by the writer, published in the Jan. number. Also editorial. 4500 w. St Ry Jour—Nov. 2, 1901. No. 44200 D.

Scotland.

The Electric Tramways of Ayr. Illustrates and describes an installation of special interest from the traffic point of view, because the resident population is so small. —28,700. 2900 w. Tram & Ry Wld—Oct. 17, 1901. No. 44185 B.

Storage Batteries.

Storage Batteries and 60-Cycle Railway Rotaries. Edward L. Reynolds. Brief illustrated description of the use of batteries in conjunction with 60-cycle rotary converters by the Hamilton (Ont.) Light and Cataract Power Co. 900 w. St Ry Jour—Nov. 2, 1901. No. 44199 D.

Street Railroad.

The System of the New Orleans and Carrolton Railroad Company. Illustrated detailed description of one of the finest equipped and operated street railway properties in the United States. 3600 w. St Ry Jour—Nov. 2, 1901. No. 44198 D.

Surface-Contact.

The Munich Surface-Contact Tramway. An illustrated description of recent improvements in this system, and the working of the trial line in Munich. 3200 w. Engr, Lond—Oct. 25, 1901. Serial. 1st part. No. 44134 A.

Switchboards.

Modern Electric Railway Switchboard Practice. G. U. G. Holman. Considers the more recent practice in switchboards for railway installations. 8500 w. St Ry Jour —Nov. 2, 1901. No. 44201 D.

Tires.

The Relation of All-Flanged Engine Tires to Track. H. Wilson. Considers the principles involved in the effects of all-flanged tires upon track, giving illustrations. 3200 w. Ry & Engng Rev—Nov. 2, 1901. No. 44177.

Tramway Conversion.

The Conversion of the Budapest Tramways from Horse to Electric Traction (Ueber den Umbau der Budapester Pferdebahn auf Elektrischen Betrieb). L. Spängler. With plans of the city and illustrations of the power stations. Two articles. 6000 w. 2 plates. Zeitschr d Oesterr Ing u Arch Ver—Oct. 18, 25, 1901. No. 44525 each B.

Trolley Lines.

The Development of Trolley Networks in Michigan. Edward J. Hart. An illustrated account of the lines radiating from Grand Rapids and connecting it with the important Lake Michigan ports. 2800 w. Elec Wld & Engr—Nov. 16, 1901. No. 44381.

NEW PROJECTS.

Albuquerque, N. M.

Atchison, Topeka & Santa Fe Improvements at Albuquerque, New Mexico. Illustrated description of extensive improvements including a hotel and station, a freight station, an office building, with an opera house and two large warehouses. 1000 w. Ry Age—Nov. 8, 1901. No. 44255.

High Speed.

High-Speed Electric Railway Traction. C. A. Carus-Wilson. The present article gives an illustrated description of the cars and their equipment, and describes investigations thus far made. 1200 w. Elect'n, Lond—Nov. 1, 1901. No. 44295 A.

New Line.

New Line of the Burlington in Iowa. An illustrated description of the work being done on the revision of the alignment of the tracks, especially describing the portion between Murray and Creston, Iowa. 1600 w. Ry Age—Nov. 22, 1901. No. 44635.

The Rock Island's New Line to El Paso. An illustrated description of important construction work between Liberal, Kan., and Carrizozo, N. M., a distance of about 392 miles. 1000 w. Ry Age—Nov. 8, 1901. No. 44254.

PERMANENT WAY AND BUILDINGS.

Bonds.

Strange Behavior of Flexible Copper Bonds on the Baltimore & Ohio Belt Line. Describes the care used in track construction and gives illustrated description of the behavior of the bonds. Also gives recommendations of Chas. M. Hobbs for applying bonds of the protected type on steam-road tracks. 1400 w. St Ry Jour—Nov. 2, 1901. No. 44205 D.

Clearing Yards.

The Chicago Clearing Yards. Illustrated detailed description of the most extensive system of yard tracks ever constructed at one location. 6000 w. Ry & Engng Rev—Nov. 16, 1901. No. 44404.

Electric Signals.

Electric Signals on Suburban and Interurban Railways. William Pestell. Read before the Am. St. Ry. Assn. Discusses the need, the devices in use, and gives a copy of the resolutions drawn up by a committee appointed by the Mass. St. Ry. Assn. 2000 w. Ry & Engng Rev—Nov. 9, 1901. No. 44272.

Rail Stresses.

Fiber Stresses in Rails Under Moving

We supply copies of these articles. See page 649.

Trains. Extracts from a paper by P. H. Dudley, presented at the Sept. meeting of the Pacific Coast Ry. Club, discussing the subject of rail sections and their relations to the permanent way and railway operations. 1400 w. Eng News—Nov. 14, 1901. No. 44392.

Railway Testing.

A Portable Accelerometer for Railway Testing. F. B. Corey. Illustrated description of this instrument and its operation. It is of great practical value to the railway engineer. 2000 w. Trans Am Soc of Mech Engrs, No. 922—Dec., 1901. No. 44446.

Rail Welding.

Automatic Apparatus for Welding Rails by Aluminothermy (Aluminothermisches Schwessverfahren mit Hülfe Eines Automatisch Wirkenden Abstichs). Dr. H. Goldschmidt. Describing the latest appliances for welding rail joints by the heat produced by the combustion of aluminum. 2500 w. Stahl u Eisen—Nov. 1, 1901. No. 44539 D.

Shops.

New Locomotive and Car Shops of Concrete Construction. Illustrates and describes the new shops of the Central Railroad of New Jersey at Elizabethport. 1500 w. Am Engr & R R Jour—Nov., 1901. No. 44101 C.

Stations.

The Modern Railroad Station. Jean Schopfer. Part first is a finely illustrated description of the recently built Quai d'Orsay station in Paris. 4000 w. Archt Rec—Oct., 1901. Serial. 1st part. No. 44115 C.

The New Victoria Station at Nottingham. Illustrated detailed description of the fine joint station used by the Great Central and Great Northern railways. 2600 w. Engng. Nov. 15, 1901. Serial. 1st part. No. 44616 A.

New Union Station at Richmond, Va. Illustrated detailed description of a fine passenger station. 1000 w. Ry & Engng Rev—Nov. 30, 1901. No. 44699.

Sydney Central Railway Station. Gives a block plan showing approaches and roads, as recommended by the N. S. W. Central Station Board. 900 w. Aust Min Stand—Oct. 31, 1901. No. 44732 B.

Terminals.

One Central Railway Terminal for Chicago. R. C. Sattley. A plan for handling all the Chicago railroads in one terminal is presented, its requirements considered, and 3 plates given. Also general discussion. 18000 w. Jour W Soc of Engrs—Oct., 1901. No. 44154 D.

Terminal Problems of Interurban Electric Railways. Editorial on the paper by Ira A. McCormick, read at the last convention of the Am. St. Ry. Assn., and the discussion that followed. 1800 w. Eng News—Oct. 31, 1901. No. 44110.

Tunnels.

Deep-Tunnel Railways. Editorial review of the report of the joint committee appointed to consider the London underground railway question. 3200 w. Engng—Oct. 25, 1901. No. 44139 A.

Maintenance of Railway Tunnels in Great Britain. Arthur Watson. Slightly condensed from a paper published by the Inst. of Civ. Engrs. 3900 w. Eng Rec—Nov. 23, 1901. No. 44494.

See also Civil Engineering, Construction.

Water Service.

Improvement of Water Service on the Union Pacific R. R. An illustrated description of the Ft. Steele pumping station, and brief notes concerning other supplies. 1700 w. Ry & Engng Rev—Nov. 23, 1901. No. 44630.

TRAFFIC.

New South Wales.

New South Wales Railways and Trade. Editorial discussing the progressive development shown in the management of the railways, and the consequent general prosperity. 1700 w. Engng—Oct. 25, 1901. No. 44141 A.

Statistics.

The Tramways of Paris in 1900 (Les Tramways Parisiens en 1900). With tabulated data of the various lines showing the progress of electric traction, analysis of costs, etc. 3500 w. Génie Civil—Oct. 19, 1901. No. 44507 D.

Train Staff System.

The Train Staff System. Describes this English system of controlling the traffic on single-track railroads. Ill. 3300 w. Ry & Engng Rev—Nov. 2, 1901. No. 44176.

Weight.

Has the Increase in Weight of Freight Trains and Locomotives Reached Its Limit? Editorial discussion of this subject, quoting from Mr. Sullivan's address before the Cent. Ry. Club. 1800 w. Eng News—Nov. 28, 1901. No. 44658.

MISCELLANY.

Railway Progress.

Notes on Railway Progress (Mittheilungen über Fortschritte auf Einigen Gebieten im Eisenbahnwesen). H. Diesel. A comparison of early and modern railway carriages, track, etc. Serial. Part I. Glasers Annalen—Nov. 1, 1901. No. 44532 D.

We supply copies of these articles. See page 649.

EXPLANATORY NOTE.

We hold ourselves ready to supply—usually by return of post—the full text of every article indexed in the preceding pages, *in the original language*, together with all accompanying illustrations; and our charge in each case is regulated by the cost of a single copy of the journal in which the article is published. The price of each article is indicated by the letter following the number. When no letter appears, the price of the article is 20 cts. The letter A, B or C denotes a price of 40 cts.; D, of 60 cts.; E, of 80 cts.; F, of $1.00; G, of $1.20; H, of $1.60. In ordering, care should be taken to *give the number* of the article desired, not the title alone.

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THE PUBLICATIONS REGULARLY REVIEWED AND INDEXED

The titles and addresses of the journals regularly reviewed are given here in full, but only abbreviated titles are used in the Index. In the list below, *w* indicates a weekly publication, *b-w*, a bi-weekly, *s-w*, a semi-weekly, *m*, a monthly, *b-m*, a bi-monthly, *t-m*, a tri-monthly, *qr*, a quarterly, *s-q*, semi-quarterly, etc. Other abbreviations used in the index are: Ill—Illustrated; W—Words; Anon—Anonymous.

Alliance Industrielle. *m.* Brussels.
American Architect. *w.* Boston, U. S. A.
American Electrician. *m.* New York.
Am. Engineer and R. R. Journal. *m.* New York.
American Gas Light Journal. *w.* New York.
American Geologist. *m.* Minneapolis, U. S. A.
American Jl. of Science. *m.* New Haven, U.S.A.
American Machinist. *w.* New York.
Am. Manufacturer and Iron World. *w.* Pittsburg, U. S. A.
American Shipbuilder. *w.* New York.
Annales des Ponts et Chaussées. *m.* Paris.
Ann. d Soc. d Ing. e d Arch. Ital. *w.* Rome.
Architect. *w.* London.
Architectural Record. *qr.* New York.
Architectural Review. *s-q.* Boston, U. S. A.
Architect's and Builder's Magazine. *m.* New York.
Armee und Marine. *w.* Berlin.
Australian Mining Standard. *w.* Sydney.
Autocar. *w.* Coventry, Eng.
Automobile Magazine. *m.* New York.
Automotor & Horseless Vehicle Jl. *m.* London.
Brick Builder. *m.* Boston, U. S. A.
British Architect. *w.* London.
Brit. Columbia Mining Rec. *m.* Victoria, B. C.
Builder. *w.* London.
Bulletin Am. Iron and Steel Asso. *w.* Philadelphia, U. S. A.
Bulletin de la Société d'Encouragement. *m.* Paris.
Bulletin of Dept. of Labor. *b-m.* Washington.
Bulletin Scientifique. *m.* Liege.
Bull. Soc. Int. d Electriciens. *m.* Paris.
Bulletin of the Univ. of Wis., Madison, U. S. A.
Bull. Int. Railway Congress. *m.* Brussels.
Canadian Architect. *m.* Toronto.
Canadian Electrical News. *m.* Toronto.
Canadian Engineer. *m.* Montreal.
Canadian Mining Review. *m.* Ottawa.
Chem. Met. Soc. of S. Africa. *m.* Johannesburg.
Colliery Guardian. *w.* London.
Compressed Air. *m.* New York.
Comptes Rendus de l'Acad. des Sciences. *w.* Paris.
Consular Reports. *m.* Washington.
Contemporary Review. *m.* London.
Deutsche Bauzeitung. *b-w.* Berlin.
Domestic Engineering. *m.* Chicago.
Electrical Engineer. *w.* London.
Electrical Review. *w.* London.
Electrical Review. *w.* New York.
Electrical World and Engineer. *w.* New York.
Electrician. *w.* London.
Electricien. *w.* Paris.

Electricity. *w.* London.
Electricity. *w.* New York.
Electrochemist & Metallurgist. *m.* London.
Elektrizität. *b-w.* Leipzig.
Elektrochemische Zeitschrift. *m.* Berlin.
Elektrotechnische Zeitschrift. *w.* Berlin.
Elettricita *w.* Milan.
Engineer. *w.* London.
Engineer. *s-m.* Cleveland, U. S. A.
Engineers' Gazette. *m.* London.
Engineering. *w.* London.
Engineering and Mining Journal. *w.* New York.
Engineering Magazine. *m.* New York & London.
Engineering News. *w.* New York.
Engineering Record. *w.* New York.
Eng. Soc. of Western Penn'a. *m.* Pittsburg, U. S. A.
Fire and Water. *w.* New York.
Foundry. *m.* Cleveland.
Gas Engineers' Mag. *m.* Birmingham.
Gas World. *w.* London.
Génie Civil. *w.* Paris.
Gesundheits-Ingenieur. *s-m.* München.
Giorn. Dei Lav. Pubb. e. d. Str. Ferr. *w.* Rome.
Glaser's Ann. f. Gewerbe & Bauwesen. *s-m.* Berlin.
Horseless Age. *w.* New York.
Ice and Refrigeration. *m.* New York.
Indian and Eastern Engineer. *m.* Calcutta.
Ingeneria. *b-m.* Buenos Ayres.
Ingenieur. *w.* Hague.
Iron Age. *w.* New York.
Iron and Coal Trades Review. *w.* London.
Iron & Steel Trades Journal. *w.* London.
Iron Trade Review. *w.* Cleveland.
Jour. Am. Foundrymen's Assoc. *m.* New York.
Journal Assn. Eng. Societies. *m.* Philadelphia, U.S.A.
Journal of Electricity. *m.* San Francisco.
Journal Franklin Institute. *m.* Philadelphia.
Journal of Gas Lighting. *w.* London.
Journal Royal Inst. of Brit. Arch. *s-qr.* London.
Journal of Sanitary Institute. *qr.* London.
Journal of the Society of Arts. *w.* London.
Journal of U. S. Artillery. *b-m.* Fort Monroe, U.S.A.
Journal Western Soc. of Eng. *b-m.* Chicago.
Journal of Worcester Poly. Inst., Worcester, Mass.
Locomotive. *m.* Hartford, U. S. A.
Locomotive Engineering. *m.* New York.
Machinery. *m.* London.
Machinery. *m.* New York.
Madrid Cientifico. *t-m.* Madrid.
Marine Engineering. *m.* New York.
Marine Review. *w.* Cleveland, U. S. A.
Mem. de la Soc. des Ing. Civils de France. *m.* Paris.
Metal Worker. *w.* New York.
Métallurgie. *w.* Paris.
Minero Mexicano. *w.* Mexico.
Minerva. *w.* Rome.
Mines and Minerals. *m.* Scranton, U. S. A.
Mining and Metallurgy. *s-m.* New York.
Mining and Sci. Press. w. San Francisco, U.S.A.
Mining Journal. *w.* London
Mining Reporter. *w.* Denver, U. S. A.
Mitt. aus d Kgl Tech. Versuchsanst. Berlin.
Mittheilungen des Vereines für die Förderung des Local und Strassenbahnwesens. m. Vienna.
Modern Machinery. *m.* Chicago.
Monatsschr. d Wurtt. Ver. f Baukunde. *m.* Stuttgart.
Moniteur Industriel. *w.* Paris.
Mouvement Maritime. *w.* Brussels.
Municipal Engineering. *m.* Indianapolis, U. S. A.
National Builder. *m.* Chicago.
Nature. *w.* London.
Nautical Gazette. *w.* New York.
New Zealand Mines Record. *m.* Wellington.
Nineteenth Century. *m.* London.
North American Review. *m.* New York.
Oest. Wochenschr. f. d. Oeff Baudienst. *w.* Vienna.
Oest. Zeitschr. f. Berg- & Hüttenwesen. *w.* Vienna.
Ores and Metals. *w.* Denver, U. S. A.
Plumber and Decorator. *m.* London.
Popular Science Monthly. *m.* New York.
Power. *m.* New York.
Power Quarterly. New York.
Practical Engineer. *w.* London.
Pro. Am. Soc. Civil Engineers. *m.* New York.
Proceedings Engineers' Club. *qr.* Philadelphia, U. S. A.
Pro. St. Louis R'way Club. *m.* St. Louis, U. S. A.
Progressive Age. *s-m.* New York.
Quarry. *m.* London.
Railroad Digest. *w.* New York.
Railroad Gazette. *w.* New York.
Railway Age. *w.* Chicago.
Railway & Engineering Review. *w.* Chicago.
Review of Reviews. *m.* London & New York.
Revista d Obras. Pub. *w.* Madrid.
Revista Tech. ed Agr. *b-m.* Catania.
Revista Tech. Ind. *m.* Barcelona.
Revue de Mécanique. *m.* Paris.
Revue Gen. des Chemins de Fer. *m.* Paris.
Revue Technique. *b-m.* Paris.
Revue Universelle des Mines. *m.* Liége.
Rivista Gen. d Ferrovie. *w.* Florence.
Rivista Marittima. *m.* Rome.
Sanitary Plumber. *s-m.* New York.
Schweizerische Bauzeitung. *w.* Zürich.
Scientific American. *w.* New York.
Scientific Am. Supplement. *w.* New York.
Stahl und Eisen. *s-m.* Düsseldorf.
Stevens' Institute Indicator. *qr.* Hoboken, U.S.A.
Stone. *m.* New York.
Street Railway Journal. *m.* New York.
Street Railway Review. *m.* Chicago.
Telephone Magazine. *m.* Chicago.
Telephony. *m.* Chicago.
Tijds. v h Kljk. Inst. v Ing. *qr.* Hague.
Tramway & Railway World. *m.* London.
Trans. Am. Ins. Electrical Eng. *m.* New York.
Trans. Am. Ins. of Mining Eng. New York.
Trans. Am. Soc. of Civil Eng. *m.* New York.
Trans. Am. Soc. of Heat & Ven. Eng. New York.
Trans. Am. Soc. Mech. Engineers. New York.
Trans. Inst. of Engrs. & Shipbuilders in Scotland. Glasgow.
Transport. *w.* London.
Western Electrician. *w.* Chicago.
Wiener Bauindustrie Zeitung. *w.* Vienna.
Yacht. *w.* Paris.
Zeitschr. d. Oest. Ing. u. Arch. Ver. *w.* Vienna.
Zeitschr. d. Ver. Deutscher Ing. *w.* Berlin.
Zeitschrift für Elektrochemie. *w.* Halle a. S.

CURRENT RECORD OF NEW BOOKS

NOTE—Our readers may order through us any book here mentioned, remitting the publisher's price as given in each notice. Checks, Drafts, and Post-Office Orders, home and foreign, should be made payable to THE ENGINEERING MAGAZINE.

Arch Bridges.

Engineering Studies. Part III. English Stone Arches. By Charles Evan Fowler. Size, 7 in. by 10.; pp. 16; plates, 8. Price, 25 cents. New York: The Engineering News Publishing Co.

A series of half-tone plates of well known bridges in Britain—London Bridge, Waterloo Bridge, Chatsworth and Maidenhead Bridges, the new Bridge of Ayr, Broomielaw Bridge, and others, with brief textual description giving the principal data and sometimes commenting upon the engineering or architectural features of the design.

Astronomical Instruments.

A Few Astronomical Instruments from the Works of Warner & Swasey, Cleveland, Ohio, U. S. A. Size, 9½ in. by 12 in.; plates, 36. Published by Warner & Swasey, Cleveland, Ohio.

A series of unusually fine half-tone engravings of telescopes, chronographs, position micrometers, graduating engines, mounted astronomical instruments and noted observatories, exterior and interior views. The text is confined to brief descriptive lines under the several illustrations.

Compressed Air.

Compressed Air—Its Production, Uses, and Applications. By Gardner D. Hiscox, M. E. Size, 6¼ in. by 9½ in.; pp. 882; figures, 545; tables, 40. Price (cloth), $5.00. New York: Norman W. Henley & Co.

A most comprehensive work, designed to bring the literature of compressed air abreast with the rapid progress it has made in practical mechanical operations. Treats of the physical and operative properties of air from vacuum to the liquid form—its thermodynamics, compression, transmission, expansion, uses for power, for refrigeration, and for hygiene, together with the appliances, tools, and machines in which it is used.

Education.

Proceedings of the Society for the Promotion of Engineering Education. Ninth Annual Meeting, Buffalo, 1901. Edited by Frank O. Marvin, Robert Fletcher, and Henry S. Jacoby. Size, 6 in. by 9 in.; pp. 348. Price, $2.50 (to libraries, $2.00). New York: Engineering News Publishing Co.

Addresses and papers at the Buffalo meeting, chiefly discussing the curriculum of engineering schools or educational methods and exercises. A valuable symposium on engineering pedagogy.

Gas Lighting.

Electric Gas Lighting. By H. S. Norrie. Size, 5 in. by 6½ in.; pp. 102; figures, 57. Price, 50 cents, 2s. 6d. New York: Spon & Chamberlain. London: E. & F. N. Spon, Ltd.

An elementary descriptive treatise, designed to enable any one of ordinary mechanical ability to construct, or at least to erect and keep in operation, much of the apparatus for lighting gas by electricity from a distance, thus realizing what the author conceives to be one of the great advantages of electric lighting. The chapters treat multiple lighting, wiring, coils and safety devices, lighting of large buildings, the selection of batteries. The book is clearly written.

High Temperatures.

High Temperature Measurements. Translated from the French of H. Le Chatelier and O. Boudouard by George K. Burgess. Size, 5 in. by 7½ in.; pp. 230; figures, 52. Price, $3.00. New York: John Wiley & Sons. London: Chapman & Hall, Ltd.

A faithful rendering into English of M. le Chatelier's work, with thorough bibliographical and general indices. The scheme of treatment followed is: general principles of thermometry; normal scales and normal thermometers; gas pyrometers; calorimetric pyrometry; electrical-resistance, thermo-electric, heat-radiation and luminous-radiation, and contraction pyrometers; fusible cones, recording pyrometers, and concluding discussion of recent developments.

Hydraulics.

A Treatise on Hydraulics. By Henry T. Bovey, M. I. C. E., LL. D., etc. Size, 6 in. by 9 in.; pp. 582; figures, 330. Price, $5.00. New York: John Wiley & Sons. London: Chapman & Hall, Ltd.

Rewritten and largely remodelled from a former edition. The additions and changes are largely in the discussion of pipe flow, accumulators, turbines, and centrifugal pumps.

Index.

The Engineering Index, Vol. III. Five Years, 1896-1900. Edited by Henry Harrison Suplee, assisted by J. H. Cuntz. Size 10 in. by 7 in. Pp. xvi., 1030. Price, $7.50, 30 shillings. New York and London: The Engineering Magazine.

A complete alphabetical index to the technical literature of the closing five years of the nineteenth century, covering the contents of more than 200 periodicals in English, French, German, Italian, Spanish, and Dutch. Each reference is accompanied by a brief descriptive note, giving the general scope of the article, its length, and the date of publication. The work is fully provided with cross references, guiding the searcher promptly and directly to any subject within the scope of the engineering profession. This work is edited from the Engineering Index appearing monthly in The Engineering Magazine for the five years which it covers, the whole having been entirely rearranged and classified alphabetically according to carefully selected catch-words indicating the actual subjects of the articles indexed, and it forms a complete guide to the latest information and most recent practice in engineering as contained in the technical periodical literature of the entire world.

Machine-Shop Practice.

Shop and Foundry Practice. Volume I. Prepared for students of the International Correspondence Schools. Size, 6 in. by 9 in.; pp. 320. Scranton, Pa.: The Colliery Engineer Co.

The first portion of a comprehensive compilation designed to cover modern advanced machine-shop practice, dealing with the subject from the apprentice's or journeyman's point of view, and arranged to accord with a system of teaching technology by correspondence. Based on typical methods and examples taken from the best American works. Volume I treats: Reading Working Drawings; Arithmetic; Measuring Instruments; Lathe Work.

Shop and Foundry Practice. Volume II. The International Correspondence Schools. Size, 6 in. by 9 in.; pp. 452. Scranton, Pa.: The Colliery Engineer.

The second volume of the series defined above, dealing with Working Chilled Iron, Planer, Shaper, and Slotter Work, Drilling and Boring, Milling-Machine Work, Gear Cutting.

Shop and Foundry Practice. Volume III. The International Correspondence Schools. Size, 6 in. by 9 in.; pp. 556. Scranton, Pa.: The Colliery Engineer Co.

The third part of this thorough treatise follows the subject through the operations of Pattern-making, Foundry Work, Blacksmithing and Forging.

Shop and Foundry Practice. Volume IV. The International Correspondence Schools. Size, 6 in. by 9 in.; pp. 430. Scranton, Pa.: The Colliery Engineer Co.

Completing the series of which the former numbers are noticed above, by the exposition of Grinding, Bench, Vise, and Floor Work, General Hints on Shop Practice, and Toolmaking.

The four volumes listed above are not for sale in the usual sense, but are prepared for the use of students taking the course of the International Correspondence Schools.

Reminiscences.

Recollections of a Civil Engineer. By D. H. Ainsworth. Size, 5½ in. by 8 in.; pp. 192. Published by the author, Newton, Iowa.

A naive and picturesque account of personal experience, chiefly in the Western United States during the early era of railway building, beginning with 1850. The fresh color and vigorous handling compensate in great measure for the lack of editorial sense—or sense of proportion—in choosing material for presentation. The book is very entertaining, and has real merit as an informal history of early civil engineering methods and conditions in America.

Sanitation.

Handbook on Sanitation. By George K. Price, M. D. Size, 5 in. by 7½ in.; pp. 317; figures, 30. Price, $1.50. New York: John Wiley & Sons. London: Chapman & Hall, Ltd.

The first part deals with the elements of sanitation—air, water supply, sewage disposal, etc.; the second, with sanitary practice in tenement houses, dwellings, public buildings, factories; the third and fourth parts treat of sanitary inspection and sanitary law, and are addressed almost entirely to conditions existing in the United States. The style is concise, and the scheme comprehensive, but the work would gain by being confined more specifically to sanitation proper, with less attempt to ground the reader in elements of general science of which he should be master before he takes up the study of sanitation.

Water Works.

Water Works Distribution. A Practical Guide to the Laying Out of Systems of Distributing Mains for the Supply of Cities and Towns. By J. A. McPherson. Size, 5½ in. by 8 in. Price, $2.50, 10s. London: B. T. Batsford. New York: D. Van Nostrand Co.

This work discusses the general arrangement of distributing systems, including the arrangement of reservoirs and water towers, the laying of mains, the arrangement of valves and fittings, and the methods of recording supply and consumption of water.

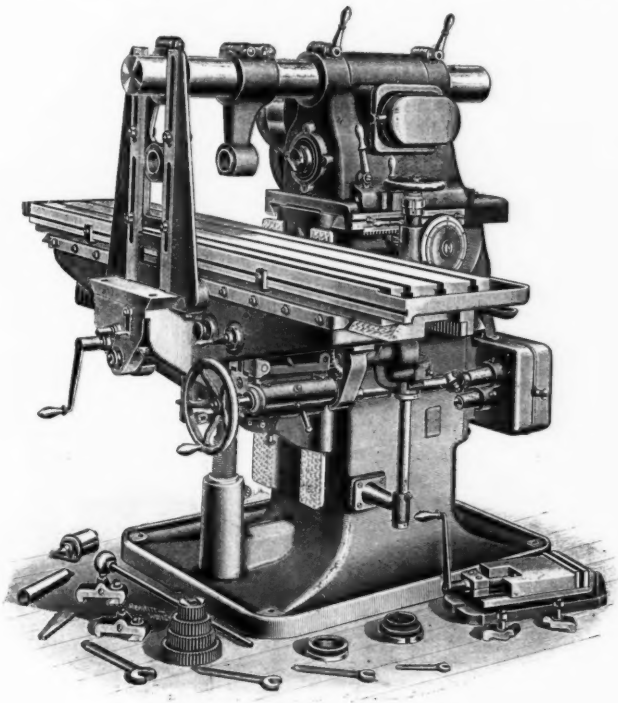
IMPROVED MACHINERY

New Processes and New Appliances

The matter here published is not paid for, nor can it be classed as advertising. But as the information is necessarily obtained from those who offer the appliances for sale, it is proper to say that the manufacturers, rather than ourselves, are responsible for the statements made.

A Plain Milling Machine.

A PLAIN milling machine, new in design and known as No. 24, has recently been brought out by the Brown & Sharpe Mfg. Co. Several important features that have not been combined before in a machine of this size and capacity are embodied in its construction.



BROWN & SHARPE PLAIN MILLER.

This machine is built for work requiring unusually large table capacity and long cuts. Exceptionally heavy gearing is provided, thus fitting the machine especially for the requirements of machine-tool builders, engine and railroad shops, and the heavier class of milling in general.

The steel spindle has ground and lapped bearings and runs in phosphor-bronze boxes, provided with means of compensation for wear. The spindle is smoothly and powerfully driven by a worm and worm wheel, the worm wheel being made of phosphor bronze, while the worm is made of steel, hardened, and runs in oil. The thrust of the worm is taken by ball bear-

ings. Provision is made for taking up the wear of the worm and wheel, thus insuring proper contact and the smooth running of the spindle.

The spindle cone runs idle and in the same direction as the shaft on which it is mounted, thus reducing the friction to a minimum. It has only two steps, the power being transmitted through a system of gearing arranged to give an exceptionally high ratio.

The changes of spindle speed are obtained by means of transposing gears. With two speeds of the counter-shaft, 8 changes of speed are obtained varying from 15 to 100 revolutions per minute. The advantages of this method of driving are readily appreciated, as the speed of the spindle cone is maintained more uniformly than when the changes of speed are wholly dependent upon the number of steps on the cone, and the power is not reduced to such an extent when slow speeds are required for heavy cuts.

The method of clamping the spindle head and knee is improved, each being clamped by one lever in place of two as formerly. This will tend to show the care and attention given throughout to the details of convenience in the manipulation of the machine.

The overhanging arm is of steel and can be pushed back from over the table when not in use.

The arm support is exceptionally rigid and of improved design. It is made in two parts, clamped directly to the front of the knee and can be easily placed in position or removed. The two parts slide upon each other and are clamped in position by bolts passing through the slots.

This form admits of a bearing for the outer end of the arbor directly in the support, and allows the adjustable arbor support to be used at any intermediate point on the arbor, thus giving an exceptionally rigid support for the arbors.

The table is supported directly in the knee, which is exceptionally long for the capacity of the machine. It is often desirable to mill work requiring large table capacity, and this feature of the long knee, which affords opportunity for long table bearings, can readily be appreciated for work of this character. Another important feature to be noted is that the table remains locked in position when the feed is automatically thrown out.

The knee or elevating screw is of the telescopic form. This does away with the necessity of providing a hole in the floor to receive the screw, as is usual in milling machine practice.

The feeds are smoothly and positively driven by chain and sprocket wheels, the various changes being made by means of change gears. They are automatic in all directions and are provided with safety stops.

The simplicity of this drive is an important feature. The object has been to secure as direct a transmission of power as possible at the least loss and at the same time provide for a wide range of feed changes. The power for this drive is taken directly from the main spindle and carried by chain and sprocket wheels to the change gears, thence to the table feed rack through a universal shaft, worm and worm wheel. It is apparent that a drive of this character insures a positive, uniform and steady feed for the table. Any lost motion that may occur can be easily compensated for by taking up the slack of the chain.

The design of this machine shows that especial care has been taken to make it as convenient in operation as possible. All the working parts are easy of access, and all levers, hand wheels, etc., are so placed that the operator has complete control of the various movements of the machine.

Test of Pipe Coverings.

A TEST of steam-pipe coverings has been made by Mr. George H. Barrus at the new power house of the Manhattan Elevated Railway Company in New York. The measure of the efficiencies of the various coverings was in the weight of water condensed in each of a number of pipes, each covered with a different heat-insulating covering, but with all other conditions as nearly alike as it was possible to make them. The coverings chosen were those which are sold for the purpose. The condensation in the pipes without any covering was also measured, and the comparison of this with the results from the protected pipes showed the great value of the cover-

ings. In general it may be stated that the condensation from the covered pipes was less than one-quarter of that from the bare pipes, while the differences in the condensation between the different coverings was so small as to practically leave little to choose between them.

It was found that the condensation was the same whether the steam was stationary in the pipes or flowing at different velocities. A brief summary of the results follows:

MINIMUM AND MAXIMUM RATES OF CONDENSATION PER HOUR.

2-INCH COVERINGS 80 POUNDS PRESSURE—LENGTH OF TEST PIPES 100 FEET.

	Min.	Max.
Johns' Asbestocol	13.46	14.07
New York Air Cell	13.88	14.14
Carey's Molded	14.18	15.00
Johns' Molded	14.15	15.07
Gast's Ambler Air Cell	14.00	15.14

2-INCH COVERINGS 150 POUNDS PRESSURE—LENGTH OF TEST PIPES 100 FEET.

Johns' Asbesto-Sponge Hair Felt, 3-ply	10.47	10.93
Johns' Asbesto-Sponge Hair Felt, 2-ply	11.21	11.39
Asbesto-Sponge Felted (Sectional)	11.20	11.67
K. & M. Magnesia (85 per cent. carb. of magnesia)	11.64	12.80
Asbestos Fire Felt (Navy Brand)	13.18	14.00

10-INCH COVERINGS 150 POUNDS PRESSURE—LENGTH OF TEST PIPES 35 FEET.

Johns' Asbesto-Sponge Felted	10.67	11.07
K. & M. Magnesia (85 per cent. carb. of magnesia)	13.00	13.64
Asbestos Fire Felt (Navy Brand)	14.00	14.64
Watson's Imperial	15.79	15.93
BARE PIPES.		
2-inch 80 lbs. pressure	55.75	60.30
2-inch 150 lbs. pressure	71.78	72.20
10-inch 150 lbs. pressure	105.09	112.00
Temperature air of Room (Approx.)	50.00	75.00

A Card-Index Improvement.

ONE of the most valuable inventions recently placed on the market is an improvement on the card index system which consists of a movable metal pointer used in connection with a series of figures or letters printed near the top edge of cards for double indexing the records. By the use of this unique device, it is possible to file cards both alphabetically and according to date at the same time in the same file, thereby obtaining results hitherto impossible without using two separate files, and being obliged to refer to both. One of the best features of this new invention is the fact that it may be adapted to any card system without rewriting the records. The pointers are made in various finishes, and their use permits a combination of cross indexing in one file which lends itself readily to the various purposes for which card systems are now used.

By referring to the accompanying illustration, it will be noted that the pointer is over the figure 25 on the card shown, and that all the cards requiring attention on the 25th. have pointers in the same relative position, bring them in a straight line, one behind the other, so that all these records

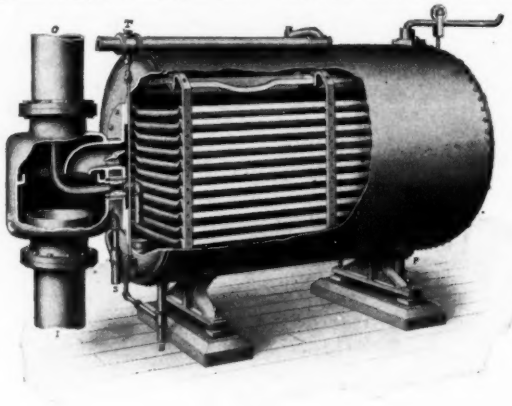
MOVABLE INDEX CARD POINTERS.

may be removed without reference to the other cards in the file, while at the same time, the alphabetical arrangement is maintained, and any particular card may readily be found.

For "following up" prospective customers, who should have attention at certain regular intervals, the system is superior, as the lists may be arranged alphabetically, geographically, topically and chronologically at the same time, in the same drawer, and any particular record found instantly. The Vetter Desk Works, of Rochester, N. Y., the owners and manufacturers of this device, have published a valuable booklet called "Business Pointers," which fully describes this system, and they will gladly mail copies free upon request.

Hoppes Induction Chamber.

WE illustrate on this page a device for connecting the exhaust steam to feed water heaters, which has for its object the reduction of cost in pipe work. The device is also an oil eliminator both for the steam used in the heater and that which flows to the atmosphere or to be used in heating systems or for other purposes. As shown in the illustration this device consists of an atachment at the rear end of the heater through which all of the exhaust steam is intended to flow. The exhaust passes through this device in an upward direction and as much as is required to heat the water passes into the heater through the large curved pipe, the open end



HOPPES INDUCTION CHAMBER.

of which is in line with the flow of the steam through the chamber. The small pipe curved upwards leads from near the bottom of the heater to the upper portion of the chamber and carries the non-condensable gases and air from the heater into the main exhaust line; this produces a perfect circulation throughout the heater and by so doing the temperature of the water flowing through the heater is always raised to the maximum. The two pipe connections to heater are provided with valves for shutting off the heater for cleaning or inspection.

From the above it will be seen that this device will not only save the expense of two or three straight-way valves and a number of large fittings, but also considerable space, which is valuable consideration, especially in steam plants of large office buildings or other places where little room is available for this purpose.

This device is manufactured by the Hoppes Manufacturing Company, Springfield, Ohio, and they have arranged by an interchangeable system of flanges to attach the same to either their standard or cast iron heaters of any size.

An Improved Panel Raiser.

J. A. FAY & EGAN CO., Cincinnati, Ohio, has just brought out a new machine which has many advantages over those at present on the market. It is especially designed for doing work in furniture factories, sash, door and blind work, and for carpenters and builders. It is their No. 1 hand feed panel raiser.

A few points it possesses are: It will do a large amount of smooth work on cross grained or knotty lumber, soft or hard wood; it will raise panels up to 3 inches on one or both sides at the same time; it is simple in operation, does not require a skilled operator, and not liable to get out of order.

The frame is substantial, all parts working true, and the operator can get close to the heads when passing the work over the table. All adjustments are made very rapidly, and the fences are always in proper position relative to the cutter heads.

The makers of this new and improved machine will willingly send full particulars

and lowest terms on application, and will also send their new poster showing this and other machines free.

A New Saw Bench.

THIS new Oliver saw bench, made by the American Machinery Co., whose headquarters are at Grand Rapids, Mich., furnishes one of the most striking examples of a machine that is the product of a multitude of special tools and fixtures. This company has for years been known as mak-

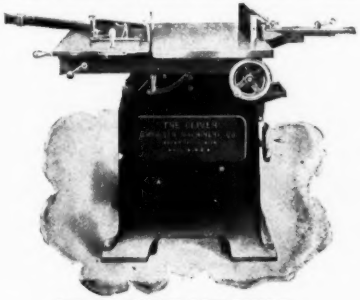


FIG. 1. OLIVER SAW BENCH.

ers of up-to-date pattern shop equipment. It is the same company that makes the well-known Oliver wood trimmers which are widely known in Europe as well as in the United States. A lifetime of work along these lines has qualified their Mr. J. W. Oliver to discharge his duties as a successful designer with exceptional skill and clever-

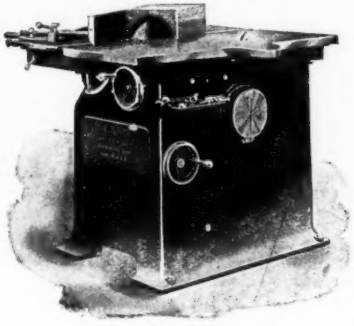


FIG. 3.

ness. The American Machinery Co. have during the past summer moved into new works and very materially enlarged their plant, installing a complete equipment of the very best iron working tools obtainable.

The Right to a Name.

THE United States Circuit Court for the Northern District of California rendered a decision on September 25 which will doubtless please every manufacturer who aims to produce goods or apparatus of the highest quality and of individual peculiarity of design. It has occasionally happened that a firm introduces a type of machine or apparatus of special design, which design becomes popularly known by the maker's name. When the patents controlling the main design expire, it can be made, of course, by others. These imitators have sometimes also taken with the design the original maker's name, which has been long associated not only with the type, but also with good material and workmanship. Such a taking of a firm name, with or without other words, is now declared to be contrary to our laws.

The subject came up in a suit brought against a California firm by the Babcock & Wilcox Company. This corporation, with its predecessor, the firm of Babcock & Wil-

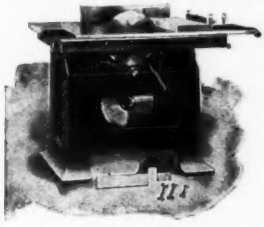


FIG. 2.

cox, has built up a high reputation for its steam apparatus by employing the best quality of workmanship and materials. The name "Babcock & Wilcox" was used from the outset by the men interested in the business as their trade name, and the Circuit Court now rules that the name identifies exclusively the steam apparatus manufactured by the company and its quality, durability, efficiency and safety, due to the care, experience, workmanship, materials, methods and tools employed by the company, and distinguishes it from all apparatus of whatsoever form or character made by other manufacturers.

The defendant, in the case tried, offered for sale, under the name "Standard Bab-

cock & Wilcox," boilers not manufactured by the Babcock & Wilcox Company. The court declared this an infringement of the company's right to its trade name and issued a perpetual injunction enjoining the defendant "from using the name 'Babcock & Wilcox,' either alone or combined with other word or words upon or in connection with the sale or offering for sale of any boiler or other steam apparatus not manufactured by the complainant, and from stating or representing that any boiler or other steam apparatus sold, or dealt in by the respondent and not manufactured by complainant, is a Babcock & Wilcox boiler, and from selling or offering for sale, or passing off any such boiler or other steam apparatus as and for boilers or steam apparatus manufactured and sold by complainant."

Advantages of Mechanical Draft.

IN the summary of advantages of mechanical draft presented in the treatise on that subject published by the B. F. Sturtevant Co., it is stated that "to a great extent they are interdependent, and the possession of one advantage is evidence of the possession of others of similar character. In a brief summary, however, these may be more readily brought into accord. Thus the very adaptability of mechanical draft is indicative of the fact that it is more flexible than that produced by the chimney, is more readily controlled, and less influenced by climatic changes, while the apparatus for its production is more readily transported and has a higher potential value than a chimney. To a considerable extent these stand out as the conveniences of this method, regardless of their economies. When it is shown that increased efficiency can be secured by a method that is more convenient, the advantage of mechanical draft is established.

"The actual omission of the chimney is sometimes of far greater importance than would at first appear, while the readiness with which the rate of combustion may be increased is doubly appreciated when it is shown that under proper conditions the efficiency of combustion may be increased thereby. The purely economic features are presented most prominently in the ability to utilize low grade fuels, the resultant economy being shown in numerous examples here presented. The economy in the quantity of fuel consumed has, in its relation to the use of mechanical draft on shipboard, an advantage which is closely allied to that resulting from the decreased space occupied.

"The economic results which may be secured through the introduction of mechanical stokers and devices for utilizing the waste heat of the gases are rendered most evident under the conditions of mechanical draft production, as are also the great advantage of preventing smoke and the blessings of good ventilation as they are exemplified on shipboard. The facts that the size of a boiler plant required for a given output can be reduced when a fan is substituted for a chimney, that the cost of the mechanical draft plant is usually far less than that of the chimney draft plant, and that its operating expense is likewise less under proper conditions, all point most conclusively to the purely economic advantages of the method which it is the purpose of this book to present. When these are considered in the light of the convenience and various other advantages of mechanical draft, its evident superiority to chimney draft must be conclusively established in the mind of anyone who has read these pages."

Industrial Notes.

A. Leschen & Sons' Rope Co., of St. Louis, Mo., have moved their Chicago offices to 137 Lake street, where they will carry a full stock of wire, manila and sisal rope, packing, pulley blocks, sheaves, wire fittings, etc.

Work is progressing rapidly on the foundations for the new plant of the B. F. Sturtevant Co., at Hyde Park, Mass. The buildings, including storage space between, will occupy a tract measuring in extreme dimensions about 500 feet by 700 feet. This will provide space for the foundry, pattern and pattern storage building, and power plant, as well as the machine shop, 120 feet by 500 feet, and a three story structure of the same length, both terminating in a large head house, which will serve for the work of erecting, testing and shipping. The office will be a separate building.

Another extension to the Bullock Elec-

tric Manufacturing Company's plant has become necessary on account of the volume of orders for heavy machinery that has come to them in the past sixty days. Work has been commenced upon a building to be 250 feet wide having a main aisle 75 feet wide, two side aisles 60 feet each and two side aisles 27½ feet each. This building is planned to be 750 feet long, but will not be built in its entirety at the present time; contracts are being let for one-half the contemplated length. It will be electrically driven throughout, having electric traveling cranes in all five aisles. The head room under the crane of the main aisle will be 50 feet, with 30 feet head room in the 60-foot aisles. The architectural features of the building will conform to those already erected; the walls being of buff brick with steel frame-work. The building is to be rushed to completion with all possible haste and will provide facilities much needed. The company is also installing at the present time in its own power house a 1,000 K. W. generator direct connected to a cross compound Lane & Bodley Corliss engine. Their new foundry is also being connected by side tracks to the system in the main works, which will permit of the use of their locomotive crane car for delivery of material to and from this portion of the plant.

The Pullman Company has finished and delivered to the Louisville & Nashville Railroad Company three dining cars equipped with the "Axle light" system of the Consolidated Railway Electric Lighting & Equipment Company. No auxiliary light has been provided in these cars. One of these cars will run between Cincinnati and Louisville and two between Birmingham and New Orleans.

The New Process Raw Hide Co., Syracuse, N. Y., through its English agents, Messrs. George Angus & Co., received during the month of October trial orders for its "New Process" noiseless pinions from no less than eleven of the leading electric railway companies in Great Britain. The company reports its trade in the general machinery line as steadily increasing, especially in the case of motor-driven machine tools where noiseless running is very essential. Since the company's announcement a couple of months ago that it is in position to furnish accurately cut metal gears also, the number of orders received for work in this line has been very gratifying and point favorably to an extended trade.

The Lidgerwood Manufacturing Company, New York City, has received four gold medals, one silver medal and one bronze medal for their various exhibits at the Pan-American Exposition. All of the awards were the highest given in each particular class, and include a gold medal for mining engines and general hoisting engines, a gold medal for electric battleship hoist such as the company furnished the U. S. S. Kearsarge and Kentucky, and a gold medal for the Lidgerwood-Miller marine cableway for coaling at sea. Also a silver medal for electrical hoisting engines and a bronze medal for the new reversible drum swinging gear which is a feature of the latest type of Lidgerwood derrick engines.,

Orders have been placed with the Watertown Engine Co., for steam engines for the electric light plant at the Hudson River State Hospital. This makes the tenth engine and the sixth installation of Watertown work in State asylums and hospitals.

An interesting shipment was made by the Erie Pump & Engine Co., Erie, Pa., a few days ago—two 7 x 7 engines coupled together and forwarded by express to New Orleans. The express charges were over $100.

The American Cement Co., Philadelphia, Pa., was awarded a gold medal the highest award given, at the Pan-American Exposition held at Buffalo, N. Y., for their "Giant" portland cement. This brand of cement has been used in many of the largest undertakings in the country, such as the Cornell dam of the Croton aqueduct system, the Rapid Transit underground railway in New York, the Niagara Falls tunnel.

A twenty-five page booklet, styled "Advertising for Profit in the Trade Journals, Fourth Edition," has been issued by the Manufacturers' Advertising Bureau, New York, and gives an outline of the Bureau's method of managing a manufacturers' newspaper work and advertising in the scientific, manufacturing and technical publications.

The Cleveland Pneumatic Tool Company have opened a Chicago office at 335 Wabash avenue, in charge of H. S. Covey, where samples of their complete line of chipping, beading and caulking hammers, the "Cleve-

land" long stroke riveting hammers, piston, rotary and breast drills may be seen.

The Cutler-Hammer Mfg. Co., Milwaukee, Wis., have found it necessary to increase their manufacturing facilities, owing to the rapid growth of their business and have added a new building to their Milwaukee factory, giving an additional floor space of 8,000 square feet, making the total space of the factory about 55,000 square feet, all of which is devoted exclusively to the manufacture of rheostats and circuit breakers.

J. I. Lyle, M. E., who has been connected with the home office of the Buffalo Forge Co., for the past five years, is now manager of their New York branch, 39-41 Cortlandt street.

ARTICLES of incorporation have been granted to the Spiral Riveted Tube Co. under the laws of the State of New Jersey for the purpose of manufacturing and dealing in spiral riveted pipe machines and pipe, etc., and conducting the business of galvanizing in all its branches. The factory is to be in Jersey City, on the Central Railroad of New Jersey and with a siding running through the principal buildings. The galvanizing department is about completed. Machines for making pipe of all sizes from 3" to 30" in diameter are now being built. The officers of the new company are John A. Wilbur, president and treasurer; A. Howard Abendroth, secretary; and Frederick W. Stapf. The latter two gentlemen were formerly with the Abendroth & Root Mfg. Co.

During the month of December, the Henry S. Mould Company of Pittsburg, Pa., shipped White briquetting presses to the following firms: The Allis-Chalmers Co. for the Backus & Johnson Co. of Lima, Peru; the Kendrick & Gelder Smelting Co. of Silverton, Col.; the Granby Consolidated Smelting, Mining and Power Co. of Grand Forks, B. C.; the United States Mining Co. of Salt Lake City, and a second outfit to the Bingham Copper & Gold Mining Co. of Salt Lake City. These machines have come into general use in Australia and Tasmania, and already the Pittsburg manufacturers have established briquetting plants at a number of smelters, among them being The Broken Hill Proprietary Co., Port Pirie, South Australia; the Mount Lyell Mining and Railroad Co. at Mt. Lyell, Tasmania; the Tasmania Smelting Co. at Zeehan, Tasmania, and the Smelting Co of Australia, Ltd., at Dapto, Lake Illawarra. The Australian agents of the Henry S. Mould Company are Knox, Schlapp & Co., 163-169 William street, Melbourne. The home office of the company is in the Empire Building, Pittsburg.

The International Correspondence Schools of Scranton, Pa., have added the study of languages to their courses. The instruction is given by means of a phonograph and specially prepared instruction papers. The languages at present comprised in the course are French, German and Spanish, the lessons being dictated to the phonograph by native teachers and the master records themselves are sent to the student. The student recites into a phonograph and in this manner he is practically in personal touch with a native instructor of the language he wishes to learn.

The Conradson Lathe Co., which has taken over the interests of the American Turret Lathe Co., of Wilmington, Del., has settled definitely upon Warren, Pa., for its new plant.

The Lehigh Valley Railroad has issued its interesting "Winter Tours," covering southern and southwestern resorts. The aim of the book is to place before those contemplating a southern trip an outline of the advantages, surroundings and facilities of the more prominent winter resorts, together with the routes by which they may be reached, etc. Complimentary copies may be had by addressing Chas. S. Lee, 26 Cortlandt street, New York.

The Jacobson Machine Mfg. Co., of Warren, Pa., have found it necessary from time to time to increase the capacity of their works, and have just completed another addition to their plant, which will greatly facilitate the business. It is an extensive addition to the moulding department. The former building, which was inadequate, was 40x71 feet, and the new structure, which includes the old, has a floor space of 71x90 feet. The structure has been completed and is now in use. It is now possible to turn out more than double the amount of work formerly possible. The company have begun the manufacture of a patent swivel vise and expect to be in a position to fill orders in the near future.

The Crocker-Wheeler Company, Ampere, N. J., is being pushed to its utmost to keep up with the large number of orders it is daily receiving and has on hand. They are constantly adding to the number of factory hands, and have for some months been working a regular night shift. Among shipments made during the last month are two 520 K. W. generators for the American Smelting & Refining Co., Perth Amboy, N. J.; three 400 K. W. and one 100 K. W. for the Alsen Cement Plant, West Camp, N. Y.; one 400 K. W. generator for the Christenson Engineering Co., Milwaukee, Wis.; one 300 K. W. generator for the Balbach Smelting & Refining Co., Newark, N. J.; three 200 K. W. generators for the Stetson & Company's new power plant, Philadelphia; one 375 K. W. generator for the Anglo-American Provision Co., Chicago; one 400 K. W. and one 75 K. W. for the Lake Shore & Michigan Southern Railroad; one 200 K. W. generator for the Vandergrift Construction Co. for railroad work; one 200 K. W. generator for the Crucible Steel Co., of Blair, Pa.; one 150 K. W. generator for Latrobe Steel Co., one 200 K. W. for the Otis Elevator Company, and one 100 K. W. generator for the United States Tube Company.

The Chicago & Northwestern Line runs through first-class Pullman and tourist sleeping cars to points in California and Oregon daily. Personally conducted tours from Chicago to San Francisco, Los Angeles and Portland leave Chicago every Tuesday and Thursday. The finest scenery and quickest time are attendant with the lowest rates. Full information may be had from any ticket agent or from W. B. Kniskern, 22 Fifth avenue, Chicago.

We neglected to mention last month that the E. Howard Clock Company of Boston and New York, was awarded a gold medal at the Pan-American Exposition. This is the only concern in the United States manufacturing watches and clocks which received the highest award, and it speaks well for the quality of their goods.

Lehigh University is erecting a stone laboratory, 90″x43″, to be used in connection with the steam engineering work of the course in mechanical engineering. Next fall they will offer a new and extended course in electro-metallurgy—the first of its kind, it is believed, to be established in this country. The departments of civil engineering and geology at the university have recently received valuable gifts in the shape of surveying instruments, microscopes and geological specimens for the microscopic study of rocks.

NEW CATALOGUES AND TRADE PUBLICATIONS

These catalogues may be had free of charge on application to the firm issuing them. Please mention The Engineering Magazine when you write.

Automobiles

A handsome folder in old-style referring to the "Stevens-Duryea" carriage. Although brief, much interesting data is given. Size, 4 pages, 6 by 8½ inches. J. Stevens Arms & Tool Co., Chicopee Falls, Mass.

Blowers

Booklet showing a full line of pressure blowers and exhausters. The journal bearing is unique and worth investigating. Size, 34 pages, 3½ by 6 inches. J. B. & J. M. Cornell, New York.

Blue Print Machine

A folder in colors, illustrating and describing the Dietzgen revolving cylinder blue print machine for blue printing by electric light. Size, 4 pages, 6 by 9 inches. Eugene Dietzgen Co., 181 Monroe Street, Chicago, Ill.

Brazing Process

A folder intended for use at the forge, and referring to "Ferrofix" and "Borfix" for brazing cast iron as easily and quickly as wrought iron or any other metal. Size, 14 pages, 5 by 12 inches. The American Ferrofix Company, 20 Broad Street, New York.

Concentrating Machinery

The eighth edition of catalogue No. 9

of the Allis-Chalmers Co. The book is replete with useful data, and many drawings and photographs show interesting installations. Size, 104 pages, 6 by 9 inches. Allis-Chalmers Co., Chicago, Ill.

Dynamos

Bulletin No. 102, illustrating the construction of direct-current generators of the split-pole type. The table of dimensions of standard engine-type generators is very convenient. Size, 16 pages, 7 by 9 inches. Sprague Electric Company, 527-531 West 34th St., New York.

Electric Lamps

A handsome brochure illustrating many designs and arrangements of electric lamps and fixtures for isolated plants. Size, 64 pages, 5 by 8 inches. General Electric Company, Schenectady, N. Y.

Feed-Water Heaters

Conveniently arranged pamphlet illustrating and describing the Hoppes feed-water purifiers, feed-water heaters, steam separators, oil eliminators and exhaust heads. Many outline drawings show the method of connecting these appliances. Size, 48 pages, 6 by 9 inches. The Hoppes Mfg. Co., Springfield, Ohio.

Gas Engines

Pamphlet illustrating in detail the Mietz & Weiss gas and kerosene engines, together with tables of sizes, efficiency, etc. Size, 24 pages, 6 by 9 inches. August Mietz, 128-138 Mott St., New York.

Gas Plants

A well illustrated catalogue illustrating gas plants for power, using gas engines; for fuel; for manufacturing and metallurgical work of all kinds; and for the manufacture of illuminating gas. Bituminous or anthracite coal, wood or its refuse, coke or peat may be used. Size, 30 pages, 7 by 9 inches. Loomis-Pettibone Company, 52 Broadway, New York.

Graphitic Steel

A folder referring to a new product from which can be produced small castings, clean, uniform, free from the blurs, holes and roughness common to steel castings. Graphitic Steel seems to offer interesting possibilities in various lines. Size, 4 pages, 3½ by 6½ inches. Graphite Metal Co., 15 Cortlandt St., New York.

Metallic Packing

A handsomely printed pamphlet in two colors, describing and illustrating with many sectional drawings the Swain metallic packing. Size, 16 pages, 7 by 9 inches. Swain Lubricating Company, Chicago, Ill.

Pumping Machinery

A very complete catalogue of pumping machinery and water and gas works appliances, giving a vast amount of technical details. The following subjects treated at considerable length are worthy of special notice, namely;—The Commercial Value of Diameters of Cast Iron Pipe, The Electrolysis of Cast Iron Pipe, Steam Pumping Engines, and Centrifugal Pumps. A carefully prepared index makes reference to any subject in the volume most convenient. Size, 176 pages, 9 by 11 inches. R. D. Wood & Co., Philadelphia, Pa.

Refrigerating Machinery

A very conveniently arranged catalogue of ice making and refrigerating machinery, steel ammonia fittings and specialties for ice and refrigerating plants, with much valuable information to one about to purchase such equipment. Size, 160 pages, 5 by 7½ inches. Triumph Ice Machine Co., Cincinnati, Ohio.

Rock Drills

A well arranged and handsomely printed brochure, showing the construction and use of rock drills, mountings and appurtenances. Full tables of sizes and weights and a very complete cable code are added. Size, 62 pages, 6 by 9 inches. McKiernan Drill Co., 120 Liberty Street, New York.

Thermometers, Recording

Circular No. 6T., showing a very extensive line of Bristol standard recording thermometers. Size, 16 pages, 9 by 12 inches. The Bristol Company, Waterbury, Conn.

Well Machinery

A profusely illustrated pamphlet showing a wide line of well drilling machinery, together with accessories. Size, 32 pages, 6 by 9 inches. The American Well Works, Aurora, Ill.

Wood Trimmers

A well designed pamphlet giving details of the Oliver wood trimmers for pattern makers. Size, 20 pages, 6 by 9 inches. American Machinery Co., Grand Rapids, Mich.